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Towards a Food Insecurity Multidimensional Index (FIMI)

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LIST OF ACRONYMS

ASTI	Agricultural Science and Technology Indicator
CPI	Consumer Price Index
DES	Dietary Energy Supply
EC	European Commission
FAO	Food and Agriculture Organization of the United Nations
FIMI	Food Insecurity Multidimensional Index
FIS	Food Intake Survey
FPI	Food Production Index
GDP	Gross Domestic Product
GHI	Global Hunger Index
GNI	Gross National Income
HIES	Household Income and Expenditure Survey
IDR	Import Dependency Ratio
NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
PCA	Principal Component Analysis
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
WB	Wold Bank
WFP	World Food Programme
WFS	World Food Summit
WHO	World Health Organization

1. INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) *State of Food Insecurity* for 2010 assesses that nearly 1 billion people are estimated to be undernourished, representing almost 16 percent of the population of developing countries.

Although the strong commitment of international institutions and the efforts conducted to reach the objective to half, within year 2015, the number of people suffering from hunger, food insecurity still represents one of the biggest challenges for a big part of the world population and must be treated with the utmost urgency.

It is generally recognized that food security, and therefore food insecurity, is a multi-dimensional phenomenon. Several indices measuring hunger and the progress in achieving hunger eradication helped understanding the issue and monitoring the progress in eliminating hunger as well as providing targets for national and international political action (Ed. Clay, 2002).

However, none of these indexes reach to capture all aspects of food insecurity, as stated by the Scientific Symposium on Measurement and Assessment of Food Deprivation and Undernutrition in 2002. The lack of a commonly accepted, comprehensive measure for food security on an international scale has been identified as one of the roadblocks on the way to the eradication of hunger and malnutrition (Heidhues and von Braun 2004). A suite of indicators is therefore needed to cover the different dimensions of food security: availability, access, utilization and stability.

This study aims to provide a first step towards the development of a multidimensional index to assess countries' vulnerability to food insecurity across all four dimensions.

The **Food Insecurity Multidimensional Index (FIMI)** will synthetize the four dimensions of food security (availability, access, utilization and stability of food), thus adopting a multidimensional, comprehensive approach.

Selected indicators deal with the theoretical challenge to investigate the narrowest aspect of food insecurity combining its causes and consequences, analysing hunger through qualitative and quantitative indicators, despite limited data availability represents one of the main obstacle to the achievement of the purpose.

Indicators are firstly aggregated by dimension; then, an overall index (FIMI) is calculated by computing these four dimensions. This way it will be possible to capture the state of food insecurity in a country maintaining a view on the impact of each dimension on the index.

Being able to focus closely on individual dimensions represents an important way to find the determinants of hunger and foresee future scenarios to allow planning policies at country-level.

The analysis is conducted on a 20 years-timeline (from 1990 to 2009) over countries which present a rate of undernourishment higher than 5% for 1990-92 and 2004-2006 in the list of countries suffering from undernourishment as defined by the United Nations World Food Programme (WFP) and FAO in its *State of Food Insecurity in the World* 2009 report. This criterion serves to build a synthetic index that can realistically capture the rationales of food insecurity and help monitoring trends of the phenomenon across countries experiencing a rooted state of food insecurity.

Expected outcomes of the study are:

1. Obtaining **four sub-indexes**, each corresponding to on one dimension of food insecurity; and
2. Developing an **overall synthetic index of food insecurity** (FIMI) for each country under analysis for different timeframes.

This will allow ranking countries according to their FIMI score, studying identified trends and deeply investigating the rationale of a country's performance across each dimension. Reliability and robustness of results will finally be tested through the support of agreed and recognized literature about the state of food insecurity in selected countries.

The study is structured as follows:

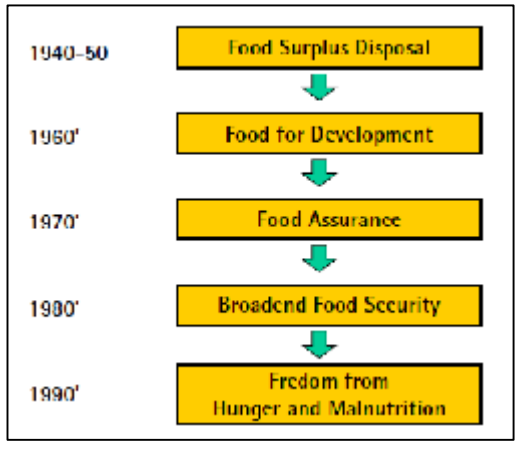
- Section 2 presents the definition of food security and its commonly adopted measurements;
- Section 3 sets criteria for the construction of the index;
- Section 4 illustrates the process of selection of indicators through the theoretical framework and results from the multivariate approach under each dimension;
- Section 5 presents the ranking of countries and identifies and discusses regional and country trends;
- Section 6 draws conclusions and sets the way forward.

2. FOOD SECURITY DEFINITIONS AND MEASURES

2.1. Definition of food security

Concerns about food security can be traced back to the Hot Springs Conference of Food and Agriculture in 1943, since which time the issue has undergone several redefinitions (Figure 1). The 1943 conference evolved the concept of a "secure, adequate and suitable supply of food for everyone" a concept that was subsequently taken up at an international level. The next step was the setting up of bilateral agencies by donor countries such as the USA and Canada in the 1950s whereby their agricultural surpluses would be shipped overseas to countries in need. By the 1960s there was a growing realization that food aid could actually hamper a country's progress to self-sufficiency and thus was born the concept of Food for Development and in 1963 its institutional expression, the World Food Programme (WFP). However, the era of an abundance of food was coming to an end and the 1972-4 food crisis marked the beginning of fluctuating food supplies and prices. To counter this, insurance schemes were set up to guarantee access to food supplies and this led to enhanced coordination among donor organizations and improved monitoring of the situation on the ground in receiving countries.

Figure 1 The evolution of Food Security concerns:



The issue of food security really came to the fore in the 1970s and at the 1974 World Food Conference in Rome the first explicit acknowledgement was made that this issue concerned the whole of mankind:

*"**Every man, woman and child** has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties. (…) Accordingly, the eradication of hunger is a common objective of all the countries of the international community, especially of the developed countries and others in a position to help." (United Nations. 1975. Report of the World Food Conference, Rome 5-16 November 1974. New York)*

Since the 1974 Rome conference the whole concept has "evolved, developed, multiplied and diversified" (Maxwell, 1996). There are now thought to be almost two hundred definitions of food security (Smith et al., 1993) which is a clear indication of differing views and approaches to the problem; however, the definition that has acquired the broadest acceptance is that of the World Food Summit (WFS) in November 1996:

*"Food security exists when **all people**, at all times, have physical, social and economic **access** to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."*

Back in the 1970s the whole problem of food security was basically seen as one of supply, stemming from a series of food crises and major outbreaks of famine that the hoped-for promises of the Green revolution had done little to avert. The main focus was on guaranteeing the availability of food as well as attempting to ensure price stability both nationally and internationally through increased food production and the use of food surpluses. This approach led to the 1974 definition of food security:

"***availability*** *at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (United Nations. 1975. Report of the World Food Conference, Rome 5-16 November 1974. New York)*

The Green revolution of the 1980s began to deliver some of its promise and levels of food production did in fact increase; however, the problem of famine did not go away and it was at this point that it was realized that the underlying cause was not so much food supply as the purchasing power of specific social groups. The definition of food security now took in the economic as well as the physical aspects of food availability and attention was drawn to ways to alleviate poverty and enhance the role of women in the development process.

The definition was further widened when Amartya Sen's book "Poverty and Famines" came out in 1981. His book made the point that the starving are often denied access to food rather than suffering because food is unavailable and in so doing introduced the idea of entitlement to food:

"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." (Sen A. 1981,Poverty and Famines)

The effect was to move the whole issue of food security out of the realm of the essentially agricultural and place it in a broader context of poverty and lack of development. This resulted in the FAO in 1983 adding the factor of access to those of production and price stability:

"…the ultimate objective of world food security should be to ensure that all people at all times have both physical and economic ***access*** *to the basic food they need. Food security should have three specific aims, namely ensuring production of adequate food supplies; maximizing stability in the flow of supplies; and securing access to available supplies on the part of those who need them." (FAO. 1983. World Food Security: a Reappraisal of the Concepts and Approaches. Director General's Report. Rome.)*

Although access is an important factor in food security it can only prevent hunger if accompanied by stability.

By 1986 and the publication of the World Bank's report "Poverty and Hunger" another component in the food security picture was making an appearance, namely the time element. Food insecurity could be categorized as either chronic or transitory with the former representing a situation where the lack of food is a permanent feature and the latter describing a temporary shortage. Chronic food insecurity basically means that that the risk of famine is high and that to guarantee food security that risk must be tackled and eliminated, giving rise to the idea of:

"Access of all people at ***all times*** *to enough food for an active, healthy life".*

A further component in the definition of food security concerned the actual quality and type of food supplied and a requirement that it should not merely satisfy protein-energy needs but provide the nutritional balance necessary for a healthy and active life; in addition to this was the recognition of preferences, traditional habits and socially acceptable food types when considering the definition of food security. The World Food Summit's 1996 definition includes these aspects when it mentions:
"**…access to sufficient,* ***safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."
This generally accepted definition describes what are known as the Four Pillars of food security: accessibility, availability, utilization and stability.

2.2 Definition of food insecurity

Food security is a difficult concept to measure since it deals in very broad terms with the production, distribution and consumption of food. Food insecurity on the other hand lends itself more readily to measurement and analysis. It should be stressed that food security and famine and hunger are not to be confused: food security refers to the availability of food whereas famine and hunger are the consequence of the non-availability of food, in other words the results of food insecurity.

The FAO definition of food insecurity is:

"A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life."
Any analysis of food security will examine whether a change from security to insecurity or insecurity to security actually takes place and also the probability of such a change happening. Factors that may lead to a situation of food insecurity include non-availability of food, lack of access, improper utilization and instability over a certain time period. The 1996 World Food Summit declared the fight against food insecurity as one of its objectives:

"This Plan of Action envisages an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015, and a mid-term review to ascertain whether it is possible to achieve this target by 2010."

This commitment was taken up at the UN Millennium Summit with the formulation of the Millennium Development Goals (MDGs) and their aim of halving the number of the hungry and undernourished in the world by 2015.

2.3. A review of hunger indices and methods to fight hunger

As has been seen, food security and hunger are by no means tightly-defined concepts and different definitions arise depending on the number of factors involved. These include the scope of the analysis, namely whether the causes or the effects of food insecurity are being examined and whether the situation is real or potential; whether the analysis is in qualitative or quantitative terms; and the level at which analysis is being carried out: a macro- or country-wide level, a meso-
micro- or household level (Massett, 2010). In 1999 Hoddi

there were almost 200 different definitions and 450 indicators. As a result, a considerable number of food insecurity indices have been assessed.

Whereas food security describes adequate access to enough food at all times ensuring a healthy active life, food insecurity basically measures hunger. This was seen at the 1996 Rome World Food Summit when governments pledged to halve world hunger levels by 2015 and again in Target 3 of the MDG's aim to 'halve between 1990 and 2015, the proportion of people who suffer from hunger'. Two main indicators measure the success or otherwise of progress towards this goal: the prevalence of underweight children and FAO calculations of the proportion of a population living below a minimum level of food-energy consumption.

In order to measure how close Target 3 was to being reached, the FAO held a Scientific Symposium on Measurement and Assessment of Food Deprivation and Undernutrition in 2002. The Symposium used five methods with the first three comparing food availability or intake with basic requirements, the fourth measuring nutritional outcomes, and the fifth measuring people's perceptions of hunger:

1) undernourishment measured using the FAO method – a combination of data from food balance sheets and surveys of household income and expenditure;

2) food insecurity measured using data from surveys of household income and expenditure;

3) dietary intake measured using individual intake surveys;

4) child nutritional status measured using anthropometric surveys

5) people's perception of food insecurity and hunger measured using qualitative methods.

Hunger, like poverty or affluence, is one of those ill-defined concepts that are hard to measure and by concentrating on trying to measure hunger itself, the causes and effects of hunger such as poor health, low productivity, poor physical and cognitive development and mortality (Dreze and Sen, 1989) might not receive the attention they deserve.

Hunger can be defined in terms of its causes, its effects or both. Two recent indices that combine both cause and effect have been developed: the Global Hunger Index (GHI) adopted and further developed by the International Food Policy Research Institute (IFPRI) at the macro-level (countries or regions); and the Action Aid Hunger Index published in 2009 that works at the micro-level (households or individuals).

2.3.1 The FAO index

The FAO index of food energy deficiency started in 1987 and was followed by a second publication almost a decade later, since then the index has been published annually. The index measures hunger as the proportion of the population with individual energy consumption below standard nutritional requirements. Hunger is

when energy deficiency causes a decrease in body weight and results in an inability to work. Three parameters are used for the measurement of hunger:

1) per capita availability of food;
2) inequality in energy intakes and
3) country energy requirements by sex and age group.

Calculation is a three-stage process where firstly the FAO uses a country's Food Balance Sheet to estimate calorie intake per person; this is followed by an estimate of calorie distribution in the population (by assuming a log normal distribution of energy consumption and calculating the coefficient of variation of energy expenditure); and finally a calorie cut-off point is established so that the number of undernourished people can be calculated (Neiken, 2003).

This index's pros and cons have been the subject of much discussion with Svedberg (2002) and Dasgupta (1993) taking issue with the FAO's cut-off points which they claim are not distribution-sensitive. As a consequence the level of undernutrition is severely underestimated because if the already worst affected section of the population is subjected to further food deficiency this will not show on the index.

2.3.2 Household income and expenditure surveys (HIES)

National household expenditure surveys are used to assess the consumption levels and welfare of a population. The food data gathered regards the amount of food acquired rather than consumed by household members and this food acquisition data has three sources:

1) purchases of food at home and away from home;
2) gifts of food or food received as payment for labour;
3) home-produced food

The amount of dietary energy that is available to a household each day is calculated by converting food items into their kilocalorie values, adding up a total and dividing that figure by the number of days under consideration. This figure is then divided by the number of adult members of the household and the adequacy of dietary energy available can be evaluated.

An estimate of energy intake should be reported as such and not include references or consideration of dietary needs unless (and this is unlikely) these have been specifically evaluated in the population concerned.

One of the advantages of estimates of energy consumption from HIESs is that intakes and distribution of dietary energy at the household-level are revealed. These estimates could be of great value if focussed on specially selected or "sentinel" countries.

2.3.3 Food Intake Surveys (FIS)

These surveys evaluate the amount of food consumed by the individual members of a household over a determined period of time, with tables be

energy and nutrient content of each food item consumed. Unlike HIESs, food intake surveys not only include information about dietary energy but also about nutrient consumption and on occasion attempt the difficult and expensive measurement of requirements and energy expenditure. In conclusion, despite the greater accuracy of the figures, they still raise problems when it comes to actually identifying hunger.

2.3.4 Qualitative Measures of Food Security

In April 1995 the United States used its food security module as part of a survey that was already in progress to measure food insecurity and hunger within the United States itself. The aim of the module was to be able to measure the extent and severity of food insecurity and hunger and the questions were aimed at eliciting information on four main areas:

1) level of anxiety concerning food budget or supply
2) perceptions that either quantity or quality of food is not enough
3) reduced food intake in adults;
4) reduced food intake in children.

A food security scale was drawn up that ran from light (worries about food running out) to quite severe (child going without food for an entire day) and the respondents could then be classified as belonging to one of four separate categories:

- Food Secure (little or no evidence of food insecurity);
- Food Insecure without hunger (a household buys less expensive food and so reduces diet quality);
- Food Insecure with moderate hunger (Food intake for adults is reduced, and adults are experiencing hunger owing to self-rationing) and
- Food insecure with severe hunger (Households with children reduce the children's food intake and children experience the physical sensation of hunger, adults show evidence of more severe hunger as a result of much reduced food intake).

With progression up the scale from security to severe hunger each separate category is clearly defined by its own severity cut-off point.

In order to implement a similar food security scale for another country, factors such as the survey's time frame (six months, a year, longer), the number of questions in the module and where to position the cut-off points would have to be addressed.

2.3.5 Anthropometric indicators

Hunger, as defined by anthropometric indicators, is 'a syndrome that results from the interaction between poor diet and disease'. (WHO, 1995) Anthropometric indicators that are commonly used are low weight-for-height (wasting), low weight-for-age (underweight), and low height-for-age (stunting) of children under the age of five. Methods do exist for measuring nutritional outcomes in adults but they are seldom used.

Undernutrition rates have direct correlations to other hunger-associated factors such as morbidity, poor productivity, and mortality (Behrman et al., 2004; Svedberg, 2000;WHO, 1995) and as such provide a valid way of predicting hunger in general terms. These rates also provide information on the distribution of varying degrees of hunger since data concerning moderately and severely malnourished children tend not to be in aggregate form.

Shocks can affect anthropometric indicators in different ways (WHO, 1995) so it can be observed that wasting, for example, caused by acute starvation or disease, indicates hunger in the short-term whereas stunting is a chronic indicator being the result of a recent or more remote shock. Being underweight, on the other hand, is difficult to interpret as it might reflect a child's failure to grow over a long time period or that child's experience of weight loss within a short time-frame.
UNICEF publishes anthropometric data for every country in the world each year in its State of the World's Children report and enables a global assessment of the scale of hunger to be made. Action can be taken in individual countries and these data provide a valid measure of progress towards the MDGs.

2.3.6 Comparison of method

The five methods examined by the Scientific Symposium on Measurement and Assessment of Food Deprivation and Undernutrition can each be applied in different ways and each be more suited depending on whether they are being used for advocacy, policy-making or research.

Table 1 Comparison of five methods for assessing hunger and malnutrition:

Method	Main indicator(s)	Level at which indicator applies	Period to which indicator applies	Relation to hunger	Relation to diet quality and micronutrients	Applicability to evaluation
FAO: DES/CV	Percentage with low energy (interpreted as inadequate)	National only	One-year average	Aims to estimate percent with food inadequacy	Could be assessed like energy	Limited; possibly for national long term policies
Household Income and Expenditure Surveys	Household energy intake	Population subgroups, national if national sample	Usually a few days; sometimes repeated to give estimates of fluctuation (e.g. seasonal) or trends	Energy intakes; if related to household requirements (not usually) gives percent with food inadequacy	Can be estimated; less common than energy	Suitable; measures of program participation, etc. need to be included, and surveys repeated
Food intake Surveys; Food Frequency	Individual intake, related to requirement, hence adequacy	Individuals, population subgroups, not usually national.	24-hour recall to a few days; may be repeated	Most direct estimate from measuring intake	Usually estimated and related to requirement	Suitable for small sample research into causality including impact evaluation
Anthropometry	Percentage underweight or stunted (children); thin (low BMI) adults	National, population subgroups; measures effects of inadequate food, not hunger itself	Point estimate of stunting reflects some months or years, underweight and thinness less time	Not specific to food inadequacy, but trends and levels may give some bounds to hunger estimates	Related, directly and through birth weight, although this needs more research	Suitable for evaluation, using measure of physical effects on growth and health
Qualitative Measures of Food Security	Percentage reporting experience of food insecurity and hunger	Individual, subgroups, national	Usually monthly, then repeated to give annual estimate	Direct estimate of reported experience and related behaviour	Not readily assessed in quantitative terms	Suitable for large-scale evaluation, with qualitative outcome measure

(Measuring hunger and malnutrition, John B. Mason Tulane University New Orleans, LA, USA)

2.3.7 The Global Hunger Index

The IFPRI has published an annual Global Hunger Index since 2006 and it was set up to assess hunger globally, monitor the progress of the MDGs and interpret trends within causal models (Wiesmann, 2006). The Global Hunger Index regards hunger as multidimensional and uses three indicators: the FAO estimate of the proportion of the population with insufficient access to food; WHO's estimate of the proportion of underweight children under the age of 5; and UNICEF's figures on mortality in children under the age of 5. An average of the three percentage rates is taken and countries are then classified in the index as serious, alarming or extremely alarming. The index's great strength is its inclusion of three different aspects of hunger; however, because they are so closely related, distortion due to double-counting can arise. Another disadvantage is that the index fails to pick up changes to outcome distribution and reacts poorly to short-term food and health shocks. The index's strong points are that the data on the whole are reliable, it can be applied to any country, and is useful for comparing different countries. The index also provides a useful accountability instrument when dealing with governments.

2.3.8 The Action Aid Hunger Index

The NGO Action Aid index measures hunger outcomes but also a country's commitments to eradicating hunger in terms of a person's legal right to food, and that country's investment in agriculture and social protection. The various parts of each component of the index are differently weighted and a country's achievements are measured against what the country has the potential to achieve. Although this index tries to monitor both outcomes and their determinants, by combining both in the same indicator double counting can occur. That said, the index can be applied to any country, it scores highly as an advocacy instrument and has global reach making it useful for country- or regional-targeting.

2.4 Conclusions

There can be no doubt of the role hunger indices have played in supplying a general definition of hunger and helping the understanding of this phenomenon. They also help to monitor progress in eliminating hunger. Different indices of either the one-dimensional type (providing estimates of hunger levels throughout the world) or of the multi-dimensional type (providing country rankings) are intrinsically different and cannot always be compared. There is no absolute measure of Food Insecurity and the different methods adopted evaluate different aspects of hunger and its effects. During the Symposium it was recognised that "**no individual measure suffices to capture all aspects of food insecurity"** and it was proposed that a "**suite of indicators was needed to cover the different dimensions of food security: availability, access, utilization and stability of access"**.

The aim of this dissertation is to propose a new multi-dimensional index of food insecurity (FIMI) that would cover the multifaceted aspects of the phenomenon and include:

The Four Pillars of Food Security

Availability, access, utilization and stability are generally recognized as the dimensions to include and analyze in any index of food security.

The challenge is to try to combine the causes and consequences of food insecurity, investigate people's well-being and development through qualitative indicators and review economic availability and access through quantitative indicators.

FIMI aims to measure the vulnerability that a country faces in dealing with food insecurity, thereby the indicators chosen for each pillar will be studied depending on the degree of vulnerability explained.

Both macro and micro level of analysis

Ranking is understood as a common practice in the policy arena in order to measure the general extent of food insecurity but at the same time decomposability is appreciated as an important way of finding the determinants of hunger and revealing possible consequences to allow specific policies to be targeted.

The actual and potential nature of the situation

Analyzing each country through their "dimensional structure" (decomposing the overall index into the different dimensions) is could be possible to reveal the dimension that most affects the overall food situation. By being able to focus closely on individual dimensions, the degree of uncertainty surrounding a possible worsening in the index of each dimension would be revealed.

3. DEFINING A MULTIDIMENSIONAL FOOD INSECURITY INDEX (FIMI)

3.1 Food Insecurity Multidimensional Index (FIMI)

Most multidimensional indices are of the composite index type where a series of dimensions specific to a particular issue are weighted and then an average is calculated. Food security (and therefore also food insecurity) itself is a multi-dimensional issue which cannot be adequately recorded by a single indicator. A multidimensional index of food insecurity is preferred and means that countries can be compared on a complex matter like food security and also provide an instrument for policy analysis where trends and changes can be identified, and for informing public opinion.

The literature supports the statistical evidence that the multidimensional approach is the right one to follow. Amartya Sen stresses the imperative of taking a multidimensional approach to both poverty and development: "Human lives are battered and diminished in all kinds of different ways, and the first task… is to acknowledge that deprivations of very different kinds have to be accommodated within a general overarching framework" (Sen 2000). Sen's generalised view obviously also takes in hunger as being one of the ways in which human lives are battered and diminished and political philosopher Martha Nussbaum lists "being adequately nourished" as the second of her 10 basic capabilities (Nussbaum, 2000).

The FIMI reflects the food insecurity situation across 61 countries and although deeply constrained by data limitations, reveals a deeper pattern of food insecurity showing the degree to which each dimension contributes to the aggregated index.

3.2. Definition of the level of analysis

At one time food security's terms of reference applied at the regional, national or even global level and described a situation where supplies did not meet needs. Over the years as certain groups were observed to be experiencing inadequate food intake despite there being an overall adequate food supply, the term food security began to be applied at a community, local, household or individual level (Foster 1992). Now food security has gone beyond the idea of food supply to encompass access (determined by food entitlements, Sen 1981), vulnerability (Watts and Bohle 1993), and sustainability (Chambers 1989) (see also Maxwell 1995).

Availability, access, utilization and stability as component parts of food security apply to forms of human organization on all levels, from the macro- or global level down to the micro- or household and individual level.

Surveys at the micro-level, namely in households, are vital for data collection but it takes time to collect the data and often the geographical area surveyed should be wider and the time period longer. Due to the fact that there was insufficient data available at the household level to cover the time series proposed, analysis in the present study has been carried out at the meso- or community level.

3.3. Definition of the unit of analysis

This dissertation analyses 61 countries from different parts of the world, and so covers all the geographical area, even if not focusing on a specific one.

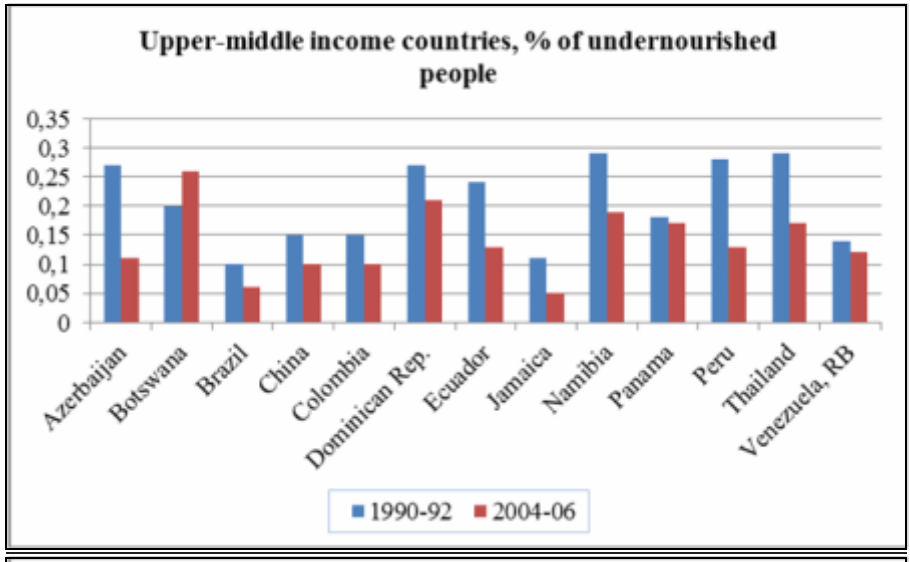
Each of the 61 countries has a proportion of the population suffering from undernourishment as defined by the United Nations World Food Programme and the UN Food and Agriculture Organization in its 2009 report "The State of Food Insecurity in the World". The countries selected were those with more than 5% of the population suffering from undernourishment in both time periods recorded in the report (1990-92 and 2004-06). Georgia was not included because of insufficient data.

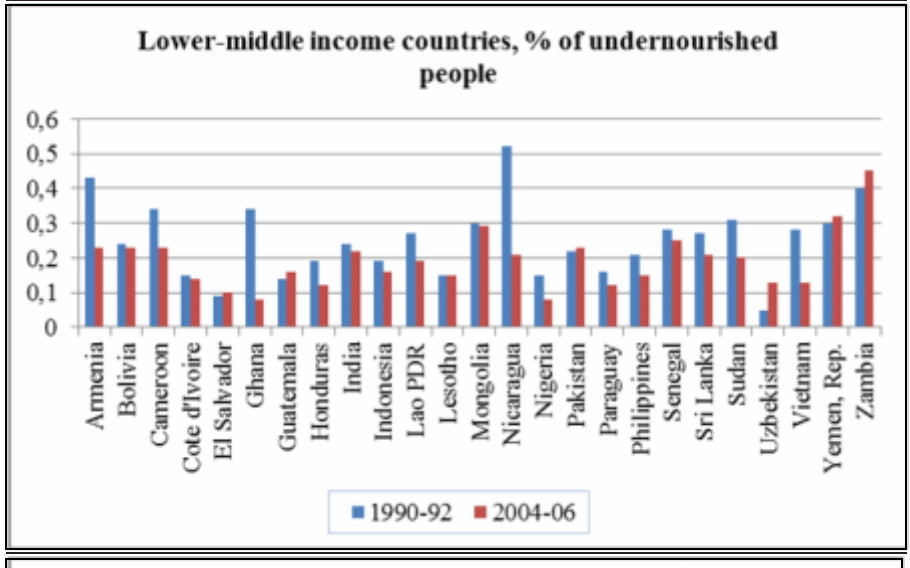
It is interesting to note income levels as defined by the World Bank of the countries analyzed. This institution ranks countries according to 2010 GNI per capita, calculated using the World Bank Atlas method. The groups are: low income, $1,005 or less; lower middle income, $1,006 - $3,975; upper middle income, $3,976 - $12,275; and high income, $12,276 or more. Of the 61 countries under examination, 13 are classified as upper middle income, 25 as lower middle income and 23 low income.

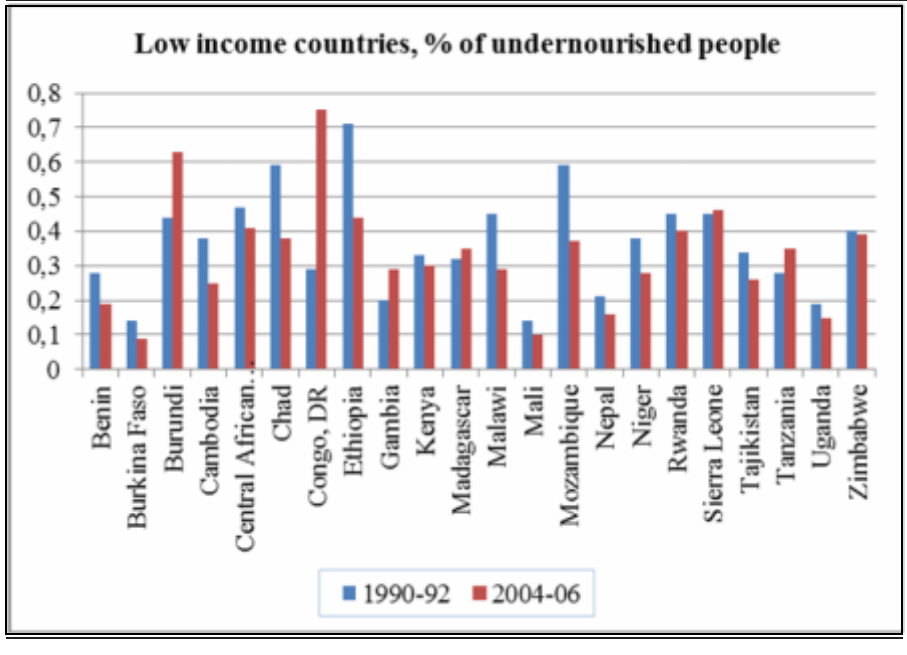
Table 2 shows that there is no strict relation between a country's income level and the proportion of the population undernourished. For example, low income countries in both reference periods such as Burkina Faso and Mali show a lower percentage of the population undernourished than Thailand or the Dominican Republic both with higher per capita incomes.

This confirms that the study of food insecurity should not concentrate exclusively on countries considered poor from an income perspective alone and that clear links between income and nutrition cannot necessarily be drawn. Mason (2002) and Glewwe et al. (2001) refer to how food intake is not simply dependent on income alone and state that there is a weak correlation between malnutrition and increased economic well-being. Penders and Staatz (2001), Smith and Haddad, (2002) and Webb and Lapping (2002) all comment on the important role that women's health and education can play in food security though they stress that their influence varies depending on time, place and social group.

TABLE 2:PERCENTAGE OF UNDERNOURISHED PEOPLE PER COUNTRY INCOME LEVEL







The data collected covers the period 1990 – 2009. As the times series could not be completed for many countries due to a lack of data, the author has decided to concentrate the study on 4 periods of 5 years: 1991-95; 1996-2000; 2001-2005 and 2006-2009. The last period is of 4 years because the majority of data for 2010 have yet to be published.

3.4. Definition of the dimensions

An integral part of the multi-dimensional nature of food security is the nutritional dimension; in addition, as the 1996 World Food Summit declared and subsequently reconfirmed in 2002, food security consists of four essential parts:

1) food availability,
2) food access,
3) food utilization
4) stability

Figure 2: Food Security Framework

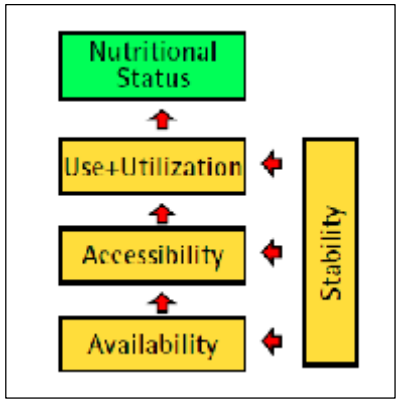


Figure 2 shows how the categories in the framework relate.

The framework comprises a physical determinant (the first three elements) and a temporal determinant (the fourth). Food might be available but that does not determine access; similarly, access might be viable but does not guarantee utilization and all three can be disrupted by a lack of stability caused by climate change, conflict, unemployment, disease or other factors. Stability or the lack of it can affect any or all of the other three components of the food insecurity framework.

3.4.1 Availability

The World Food Programme defines availability as "The amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid". (WFP, 2009, p.170). Riely et al 1995, confirms that the term tends to be applied to food available at a regional or national level rather than at the household level, which can lead to some confusion as the word "availability" sometimes is used at the micro-level.

3.4.2 Access

The World Food Summit defines access as having "physical, economic and social access". Access is still not commonly accepted as an essential part of food security despite Amartya Sen's introduction of the concept in the early 1980s. Many people only consider access within an economic or financial context, particularly since the 2005 Niger food crisis and the start of food price volatility in 2008. The World Food Programme defines food access as "A household's abili

amount of food regularly through a combination of purchases, barter, borrowings, food assistance or gifts". (WFP, 2009, p. 170).

Food access consists of three elements, which are physical, economic/financial and socio-cultural. The physical dimension can be illustrated by a situation where food is being produced in one part of a country but an inefficient or non-existent transport infrastructure means that food cannot be delivered to another part suffering from a lack of food.

From the economic viewpoint, food security exists when people can afford to buy sufficient food. The idea that food insecurity arises when food is available but people are unable to afford it is still quite a recent development in the history of food security. A further economic consideration is the importance of market systems to ensure access to food as OXFAM points out: "Even in rural areas most people, and especially the poor, rely on market systems to provide food and essential goods and services but also for selling their produce". (OXFAM, 2007).

The third element is the socio-cultural dimension which arises when food may be physically available and the potential consumer has the money to buy the food but is prevented from doing so for being a member of a particular social group or even gender. Social conflict and civil strife can seriously disrupt food production and lead to the loss of livestock for example with dire consequences for a household's future food security (Riely et al. 1999, 22).

3.4.3 Utilization

The World Food Summit's definition of utilization (the third element of food security) is "safe and nutritious food which meets their dietary needs". The availability of and access to food on their own are not enough, people have to be assured of "safe and nutritious food". The food consumed has to provide sufficient energy to enable the consumer to carry out routine physical activities. Utilization also covers factors such as safe drinking water and adequate sanitary facilities to avoid the spread of disease as well as awareness of food preparation and storage procedures. Utilization therefore covers a range of aspects that hinge on the consumer's understanding of what foods to select and how to prepare and store them. It is often a mistake to assume that the members of so-called traditional societies know how best to use food resources and it is also a fact that dietary habits (breast-feeding, weaning foods) change very quickly, even for traditional societies.

3.4.4 Stability

The World Food Summit says that stability must be present "at all times" in terms of availability, access and utilization for food security to exist. The literature distinguishes between chronic food insecurity where food needs cannot be met over a protracted period of time and transitory food insecurity, where the time period is more temporary (Maxwell and Frankenberger 1992).

3.5. Definition of the data sources

Combining composite indicators into a quality framework is not an easy undertaking depending as it does on the quality of the original data and the quality of the procedures used. Data can only really be deemed "fit for use" if, first, the data are accurate; second, they are in time to be of use; third, they can be easily accessed; and finally, they do not conflict with existing data (OECD, 2005).

There are myriad sources of data on food security but in order to guarantee the framework's reliability and consistency the sources chosen are all UN Agencies: FAO, ACQUASTAT, WB, WHO, UNDP.

Data gathering proved to be one of the biggest challenges in conducting this study. Unfortunately, due to gaps regarding the data needed, the countries selected and the time series considered, the author has been obliged to reduce the scale of analysis. Therefore, countries with less than 70% of the data required were not taken into account and the time series was reduced from 1990 – 2009 to four five-year periods.

3.6. Imputation of the missing data

By focusing on five-year periods the author has been able to take into account the data value for the year of reference and, when missing, to impute the data from the four previous years through explicit modelling. In this case, predictive distribution is based on a formal statistical model where the assumptions are made explicitly, a regression imputation. The author has applied the statistical tool from IBM "SPSS" to make the data imputation.
With the regression imputation and in particular, linear interpolation, the missing values are substituted by the predicted values obtained from regression. The dependent variable of the regression is the sub-indicator hosting the missing value, and the regressor(s) is (are) the sub-indicator(s), showing a strong relationship with the dependent variable, i.e., usually a high degree of correlation.
Suppose a set of h-1<Q fully observed sub-indicators ($x_1,\ldots,x_{h-1}$) and a sub-indicator x_h only observed for r countries, but missing for the remaining M-r countries. Regression imputation computes the regression of x_h on ($x_1,\ldots,x_{h-1}$) using r complete observations, and impute the missing values as prediction from the regression:

$$\hat{x}_{ih} = \hat{\beta}_0 + \sum_{j=1}^{h-1} \hat{\beta}_j x_{ij} \quad i = 1,..,M \quad r$$

If simplicity is its main appeal, it is important to recognize that a strong limitation of the regression imputation method is its systematic underestimation of underestimation of the standard errors, although stochastic regression ameliorates the distortions. Hence, the inference based on the entire dataset, including the imputed data, does not fully count for imputation uncertainty.

4. BUILDING THE MULTIDIMENSIONAL INDEX

This chapter explains and analyzes for each pillar, the chosen indicators by:

- the theoretical framework;
- the multivariate approach.

4.1. Theoretical framework

The development of a theoretical framework should provide the basis for the selection and combination of single indicators into a meaningful composite indicator under a fitness-for-purpose principle. In the practice the selection of the indicators deals also with the availability of complete and consistent data. Indicators must be selected in a very complex combination of statistical techniques, theoretical soundness and availability of accurate data (OECD, 2005).
Given the previous limitation the indicators are chosen for each dimension on the principles of accuracy (using as many indicators as necessary so that analysis can properly guide policy) and parsimony (using as few indicators as possible to ensure ease of analysis for policy purposes and transparency).
The phenomenon is a multi-faceted concept that cannot be directly measured. The underlying hypothesis of this kind of analysis is that the phenomenon to be measured may be indirectly observed by several indicators, which describe different features/aspects of the phenomena of food insecurity.

Table 3: Selected indicators

Dimension	Indicator	Source
AVAILABILITY	Arable land (hectares per capita)	FAO
	Cereal per yield (kg per hectare)	FAO
	Cereal domestic supply (kg per capita)	Author's calculation
	Share of food aid (% of food aid in the total Dietary Energy Supply)	WB
	Food supply (kcal/capita/day)	FAO
	Permanent cropland (% of land area)	FAO
	Food production index (1999-2001 = 100)	WB
	Land under cereal production (hectares per capita)	Author's calculation
ACCESS	Consumer price index (2005=100)	WB
	GDP per capita (current US$)	WB
	Improved water source, rural (% of rural population with access)	WB
	Rural population (% of total population)	FAO
UTILIZATION	Cereal waste (kg per capita)	Author's calculation
	Mortality rate, under-5 (per 1,000)	WB
	Prevalence of undernourishment (% of population)	WB
STABILITY	Cereal stock variation (kg per capita)	Author's calculation
	Variability of food production index	Author's calculation
	Variability of consumer price index	Author's calculation
	Import Dependency Ratio	Author's calculation
	Variability of area harvested	Author's calculation

Choosing different aspects and indicators is equivalent to choosing the 'framework' of the index.
The indicators used in this study are considered proxies for the four dimensions of food security measured at the national level: food availability, food access, food utilization and food stability.
For better cross countries comparison and classification and for deeper understanding of the phenomenon the four dimensions are expressed in 20 variables (Table 3): 8 for the Availability dimension, 4 for the Access dimension. 3 for the Utilization dimension and 5 for the Stability dimension.

4.2. The multivariate approach

Multivariate analysis is carried out to verify internal data consistency within each dimension. Some general considerations are due at this point. In the setting-up of a composite each dimension is designed to describe a particular aspect of the latent phenomenon which is viewed as a 'combination' of related still different aspects. This implies that a desired feature of the composite framework is to have a high level of correlation within each dimension that would imply, in turn, that a unique single aspect is underlying each dimension. To assess, ex ante, that the selected indicators fulfill this requirement, a dimensionality reduction method is applied: the Principal Component Analysis (PCA) is employed separately for each dimension. The software SPSS has been used to conduct this study.
Standard practice in PCA is to choose relevant dimensions if they (OECD, 2008):

- are associated to eigenvalues above one (Kaiser's rule);
- individually account to total variance by more than 10%;
- cumulatively contribute to total variance by more than 60%.

For each dimension an overall PCA is carried out with all the indicators included in the dimension to assess/confirm the number of relevant indicators 'behind' the dimension itself. In order to conduct a deeper exploratory analysis investigating the degree of representativeness of each indicator they have been all extracted.
The main goal of PCA for the Food Insecurity multidimensional index is to statistically detect the number of underlying indicators within each dimension. The statistics used in the next tables are based on data from the 61 countries of analysis for 2005. The indicators chosen in this way are then been adopted to compute the index also for 1995, 2000 and 2009.

4.3. Availability:

4.3.1 Theoretical framework

The indicators selected, within the availability of data at national level, aim to express the amount of food that is present in a country. The availability dimension is built on 8 indicators further detailed.
The "presence" of food in a country represents the first necessary element in order to achieve food security; in this study "food" has been interpreted mostly as cereal and starchy food.

The criteria in selecting the indicators have been to underline three aspects of food availability:

1) Presence of fundamental "inputs" for food production - represented by
   - Arable land
   - Permanent cropland
   - Land under cereal production per capita
2) Feedback on the effective result of this "inputs" – represented by:
   - Cereal per yield
   - Food production index
3) The supply component and its structure - represented by:
   - Cereal domestic supply
   - Share of Food Aid
   - Food supply

It is important to notice that "per capita" indicators, both related to production or supply represents only the average available for each individual in the population as a whole and do not indicate what is actually owned or consumed by individuals.

Arable land is expresses in hectares per person and includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.

Permanent cropland is expressed in % of land area and it assesses the land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber.

Land under cereal production is reported over the total population of the country in order to assess, in hectares, the area cultivated in cereal that each person virtually possesses. Land under cereal production refers to harvested area, although some countries report only sown or cultivated area. Cereals include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.

The previous three indicators give a picture on the availability of lands and of their utilization, investigating the temporary and the permanent crops, and assessing the sharing of each person to enjoy of the country's inputs.

The following two indicators show the effective production of cereals and edible food crops, so they give a precise indication on how much food is produced and thereby available in a country. Furthermore Food Production Index gives a simply and intuitive overview of the trend in food production (considering 1999- 2000=100) allowing immediate comparison between different years.

Cereal per yields is measured as kilograms per hectare of harvested land, includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.

Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.

As previously said the availability dimension refers to the amount of food present in a country. The indicators presented before investigate the production of food in a country and the "supply side" represents the effective output of the production. But the availability of food is due also to imports and food aid beyond the domestic production and the next three indicators aim to investigate the origin of food availability.

Cereal domestic supply is expressed in tons, then reported over the total population and finally converted in kilograms per capita. This indicators shows the supply for domestic utilization as Production + imports - exports + changes in stocks (decrease or increase).There is no doubt that production, imports and stock changes (either decrease or increase in stocks) are genuine supply elements.

Food aid is expressed as the share of food aid in the total Dietary Energy Supply (DES). In particular this indicator assesses the contribution of food aid shipments (cereals and non-cereal products) in total food consumption. Data on food aid in tones are converted in kilocalories using conversion factors by commodities in order to transform the data in DES.

Food supply is expressed in kilocalories per capita per day. This indicator estimates of per capita food supplies available for human consumption during the reference period in terms of quantity, caloric value, protein and fat content. Calorie supplies are reported in kilocalories (1 calorie = 4.19 kilojoules). Per capita supplies in terms of product weight are derived from the total supplies available for human consumption (i.e. Food) by dividing the quantities of food by the total population actually partaking of the food supplies during the reference period. Even if they are taken as approximation to per capita consumption, it is important to note that the amount of food actually consumed may be lower than the quantity shown here, depending on the degree of losses of edible food and nutrients in the household, e.g. during storage, in preparation and cooking etc. Again, food security cannot be studied from one dimension perspective but must be analyzed from a multidimensional point of view: availability of food as food produced, calories consumed, lands cultivated is necessary but not sufficient to understand phenomena related to food insecurity.

4.3.2 Multivariate analysis

In consistency with the different sources of indicators which describe this dimension, the PCA analysis depicts that availability cannot be uniformly represented by only one from the selected indicators.

This can be easily seen in the scree plot (Figure 3) which reveals that there is not a unique component that describes the entire dimension but the whole set of indicators included in the pillar is needed. The correlation matrix (Table 4) accordingly shows that the indicators present meaningful correlation but non at very high level.

Table 4: Correlation matrix

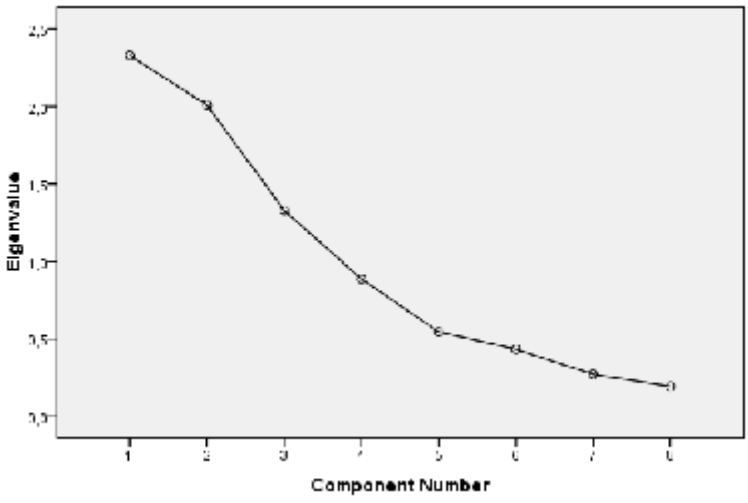
Correlations

	Pearson Correlation	1							
	Sig. (2-tailed)								
	N	61							
	Pearson Correlation		1						
	Sig. (2-tailed)								
	N								
	Pearson Correlation			1					
	Sig. (2-tailed)								
	N								
	Pearson Correlation				1				
	Sig. (2-tailed)								
	N								
	Pearson Correlation					1			
	Sig. (2-tailed)								
	N								
	Pearson Correlation						1		
	Sig. (2-tailed)								
	N								
	Pearson Correlation							1	
	Sig. (2-tailed)								
	N								
	Pearson Correlation								1
	Sig. (2-tailed)								
	N								

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Figure 3: Availability – Scree plot



The first three PCA components explain more than 70% of total variation (Table 5). Overall, the multivariate analysis indicates that all the indicators contribute in a balanced way to the availability dimension and this supports the choice of selecting all the analyzed indicators for this dimension.

Table 5: PCA analysis - correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component							
	1	2	3	4	5	6	7	8
arable land	-,783	,434	-,109	,210	,085	-,346	,130	,293
cereal yield	,782	,350	,079	,024	-,352	,202	,334	,044
land under cereal prod.	-,667	,537	-,094	,314	-,074	,307	-,013	-,252
cereal domestic supply	,235	,731	,238	-,346	,120	,251	-,257	,123
food supply	,468	,672	-,194	,042	,450	-,254	,143	-,135
share of food sic	-,149	-,330	,709	-,040	,042	,214	,130	-,023
food prod index	,052	,376	,748	,386	,201	,312	,136	,076
perm cropland	,670	,272	,165	,687	,187	,157	,131	,102

Extraction Method: Principal Component Analysis.

a. 8 components extracted.

Table 6: PCA analysis for availability dimension: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,329	29,106	29,106	2,329	29,106	29,106
2	2,008	25,102	54,208	2,008	25,102	54,208
3	1,329	16,619	70,827	1,329	16,619	70,827
4	,887	11,092	81,919	,887	11,092	81,919
5	,546	6,821	88,740	,546	6,821	88,740
6	,434	5,422	94,162	,434	5,422	94,162
7	,272	3,404	97,566	,272	3,404	97,566
8	,195	2,434	100,000	,195	2,434	100,000

Extraction Method: Principal Component Analysis.

4.4 Access

4.4.1 Theoretical framework

Access is probably the more difficult dimension of food security to analyze as it intrinsically includes very different aspects: economic, physic and social access all together shape the possibility for a person to access the food. Four indicators have been selected to study this dimension giving more space to the economic aspects for reasons of data availability further explained.

The ideal assessment would allow studying this dimension from the three aspects through both quantitative and qualitative indicators. Unfortunately very few data exist at country level on physical and social access and despite the recent literature always more acknowledge the need for going beyond the economic aspect of access still very few statistics are available.

In the initial phase of data collecting some indicators of physical access were chosen within the data published by the World Bank. Paved road (% of total road), logistics performance index and railways and roads passengers carried (million passenger-km) were thought as proxy for physical access as they measure the mobility and the quality of the logistics/ infrastructure in the country.

Also the indicators on "People affected by natural disaster' could be considered to be a proxy for physical access ba

relation as natural disasters, mainly drought, but also floods, are the main cause of food emergencies. Many of the affected countries have been plagued by severe food shortages over several years, a decade or longer. E.g., drought has contributed to several famines in Africa with millions of people affected over the past 30 years . Surveys conducted on market system and market chains are very useful to gauge households dependency on markets for food and their capabilities to access food through markets. Market surveys can show the market response capacities to cover national food demand gaps being an important tool to formulate early warnings. Now a day more and more surveys are conducted at regional and local level but still the availability of data at national level represents an issue. Data on markets were collect during the preparatory phase of the dataset used for this study, but they were than excluded.

Although those data were discarded either because they did not cover enough time series or because they were not available for all the countries under analysis, those indicators must continue to be collected in order to improve further studies in the assessment of the access dimension.

Social access is connected with a very high level of individual and qualitative analysis. This aspect of the access dimension deals with being a member of a particular social group or even gender and for this reason is very difficult to measure. In this study this area has been neglected but two selected variables aim to investigate the physical link between being food insecure and living in the rural area and the social link between being in rural area and having access to water:

- Rural population
- % of people with access to water

Rural population is expressed by the share of total population. Rural population refers to people living in rural areas as defined by national statistical offices. It is calculated as the difference between total population and urban population.

Improved water source refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Reasonable access is defined as the availability of at least 20 liters a person a day from a source within one kilometer of the dwelling.

The indicators chosen to investigate the economic aspect of access aim to show the different variables that can determine the possibility for a person to buy food. The indicators selected analyze economic access at two levels:

1) Macro level: demand and supply side
- Consumer price index

2) Micro level: potential expenditure
- GDP per capita

An attempt to go further in this direction has made by collecting data also for "Poverty headcount ratio (% of population)" at both national poverty li

day (PPP), but unfortunately those indicators have been then discarded as they were not fully completed with respect to the criteria applied.

Consumer price index is computed with 2005=100 and reflects changes in the cost of the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. This indicator gives an immediate picture of the supply side because it reflects the prices at which the commodities can be bought by the consumer. The indicator on consumer price index, if combined with an indicator of economic richness of the households (like the GDP per capita), can also reveals the possibility to access the food from the most economically vulnerable part of the population.

GDP per capita is gross domestic product divided by midyear population and gives a clear indication on the economic mean of the individual and therefore on his effective possibility to buy the food.

4.4.2. Multivariate analysis

A rather low correlation characterizes the indicators included in the dimension (Table 7).

Table 7: Correlation matrix

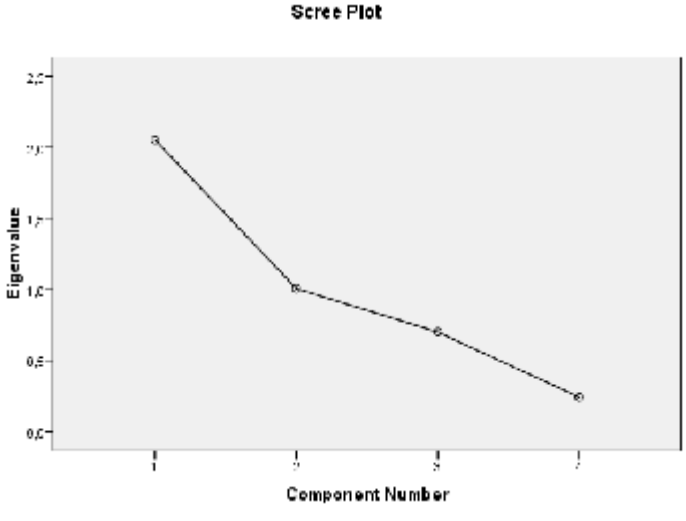
Correlations

		Consumer price index	GDP per capita	% rural pop with water access	Rural population
Consumer price index	Pearson Correlation	1	-,007	-,098	,050
	Sig. (2-tailed)		,957	,453	,703
	N	61	61	61	61
GDP per capita	Pearson Correlation	-,007	1	,674**	-,727**
	Sig. (2-tailed)	,957		,000	,000
	N	61	61	61	61
% rural pop with water access	Pearson Correlation	,098	,674**	1	,313*
	Sig. (2-tailed)	,453	,000		,014
	N	61	61	61	61
Rural population	Pearson Correlation	,050	-,727**	-,313*	1
	Sig. (2-tailed)	,703	,000	,014	
	N	61	61	61	61

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 4: Access – Scree plot



This is due to the intrinsic nature of the indicators which describe very different aspects related to the access to food. However the behavior of the indicators shows to be quite meaningful: for example, "GDP per capita" is negatively correlated to the numerousness of the rural population indicating that to an increase of the first a decrease of the second is waiting, that means that being a rural inhabitant makes more difficult to increase its own GDP and by consequence it affects the economic access to food.

Table 8: PCA analysis - correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component			
	1	2	3	4
GDP per capita	,916	,124	-,101	,368
Rural population	-,839	-,101	,447	,295
% rural pop with water access	,706	-,126	,684	-,131
Consumer price index	-,111	,982	,146	-,033

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

The PCA analysis highlights the presence of one prevalent dimension that explains almost the half of the variance and that is strongly represented by "GDP per capita" "Rural population" and "% of rural pop. with water access". But the analysis of both the scree plot (Figure 4) and the cumulative percentage of explained variance (Table 9) suggests the presence of a second minor dimension which accounts for about 25% of the total variance. This component is mainly represented by the indicator "Consumer price index" with which it has the highest correlation, 0.982 (Table 8).
Overall, the multivariate analysis indicates that all the indicators contribute in a balanced way to the availability dimension and this supports the choice of selecting all the analyzed indicators for this dimension.

Table 9: PCA analysis for access dimension: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,054	51,341	51,341	2,054	51,341	51,341
2	1,007	25,163	76,505	1,007	25,163	76,505
3	,699	17,402	93,906	,699	17,402	93,906
4	,241	6,014	100,000	,241	6,014	100,000

Extraction Method: Principal Component Analysis.

4.5. Utilization

4.5.1. Theoretical framework

The utilization dimension refers to the quality and safety of food but also to his preparation and the storage procedures. While the first two aspects are generally related to nutrition and deeply investigated, preparation is strongly interconnected with the habits and traditions carried in the household and therefore more difficult to analyze. Storage, on the contrary, can be interpreted by a quantitative measurement of the losses of food and therefore is more easily analyzable through, as in this study, indicators of waste of food.
The investigation of this dimension has involved the following 4 indicators but after the analysis only 3 were choosen:

1) Cereal waste (kg per capita)
2) Life expectancy at birth, total (years)
3) Mortality rate under 5 (per 1,000)
4) Prevalence of undernourishment (% of population)

Cereal waste, as previously introduced, it represents in kg per capita the amount of cereals lost through wastage (waste) during the year at all stages between the level at which production is recorded and the household, i.e. storage and transportation. This indicator can be very useful in detecting criticalities caused by the storage and logistic facilities.

Utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals
Thus, food security is a constituent part of the broader concept of nutrition security: food security is a necessary but insufficient condition for ensuring nutrition security.
Furthermore, also the temporally distinction of food security in chronic and transitory food insecurity is strictly linked to a nutritional evaluation.
Those have been the determinants in the selection of two of the indicators for utilization: Life expectancy at birth, total (years) and Prevalence of undernourishment (% of population).

The focus of attention in studies about malnutrition is often driven to the children and pregnant women because most of the irreversible damage due to malnutrition happens during gestation and in the first 24 months of life (the "1000 days window of opportunity"). Malnutrition is communicable through the so called "intergenerational cycle of growth failure" developing important effects of malnutrition on children: increased severity of disease, restricted intellectual development that make malnutrition being the largest cause of child mortality.
"The nutritional status of children provides an indirect measurement of the quality of life of an entire population" (WHO)

This attention is captured by the indicator on "Mortality rate under 5 (per 1,000)" that is the probability per 1,000 that a newborn baby will die before reaching age five if subject to current age-specific mortality rates.

The selected indicators have the limit that do not deeply investigate the level of malnutrition especially in children and therefore the connection between the severity of food insecurity and the nutritional status of the population is less evident. To try to overcame this limitation data on: Prevalence of wasting (% of children under 5), Malnutrition prevalence, weight for age (% of children under 5) and Malnutrition prevalence, height for age (% of children under 5) were collected. The aim was to highlight the presence of acute malnutrition, chronic malnutrition and underweight to detect the trend of food insecurity of the country analyzed through, respectively, the first, second and third indicators.
Unfortunately in assembling the data it was evident that those indicators were not available for many of the selected countries. The possibilities were so to restrict the number of countries analyzed or to exclude those indicators from the dataset. This last option was preferred giving priority to the extension of the geographical area covered by the final index.

4.5.2. Multivariate analysis

In consistency with the diversity of the aspect of utilization captured by the indicator on cereal waste and the other three referred to nutrition, the correlation matrix (Table 10) shows a high positive correlation inside the indicators on life expectancy, prevalence of undernourishment and rate of mortality if children under 5, while the correlation is, still positive, but at a lower degree with the indicator on waste.
In particular the indicators "Life expectancy at birth" and "Mortality rate under 5" show a very high degree of correlation, -0,895. The two indicators are clearly very negatively correlated as to the increasing of the life expectancy at birth corresponds a decrease in mortality rate under 5.

Table 10: Correlation matrix

Correlations

		Cereal waste	Life exp.	Mortality under 5	Prev. of undern.
Cereal waste	Pearson Correlation	1	,080	,057	,343*
	Sig. (2-tailed)		,541	,661	,027
	N	61	61	61	31
Life exp.	Pearson Correlation	,080	1	-,895**	-,552**
	Sig. (2-tailed)	,541		,000	,001
	N	61	61	61	31
Mortality under 5	Pearson Correlation	-,057	-,895**	1	,563**
	Sig. (2-tailed)	,661	,000		,001
	N	61	61	61	31
Prev. of undern.	Pearson Correlation	,343*	-,552**	,563**	1
	Sig. (2-tailed)	,027	,001	,001	
	N	31	31	31	31

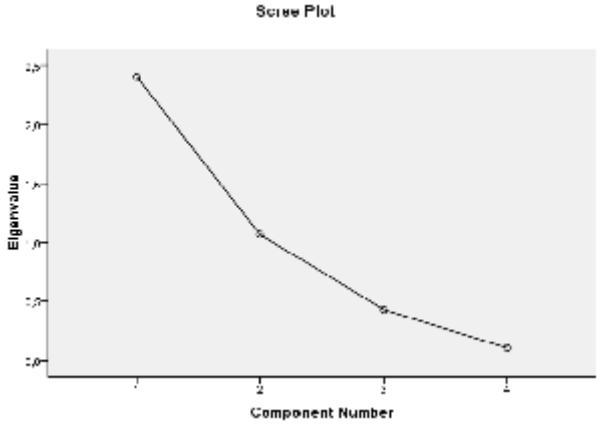
**. Correlation is significant at the 0.01 level (2-tailed).

The results of PCA confirm that the most significant latent dimension, that explains more than 60% of variance is composed by the three indicators related with health and that the indicators "Life expectancy at birth" and "Mortality rate under 5" have very close correlation respectively, -917 and +918, with the component explained (Table 11).
Those high levels of correlation between indicators can be read as a signal of redundancy and could suggest that indicators are overlapping. For this reason "Life expectancy at birth" has been excluded from the analysis. The choice to
this indicator with respect to "Mortality rate, under 5" was driven by the

framework proposed for the utilization dimension. The WFS definition itself describes the utilization dimension in terms of nutrition: "…*sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."* And in particular, the nutritional status of children provides an indirect measurement of the quality of life of an entire population (WHO). For this reason is possible to affirm that the rate of life expectancy can be foreseen through the rate of children malnutrition. Furthermore malnutrition is the first cause of children mortality, WHO has extrapolated mortality rates of children suffering from severe acute malnutrition. The mortality rates reflect a 5–20 times higher risk of death compared to well-nourished children. Severe acute malnutrition can be a direct cause of child death, or it can act as an indirect cause by dramatically increasing the case fatality rate in children suffering from such common childhood illnesses as diarrhea and pneumonia. As the nutritional status of children can be used to detect their mortality rate, the opposite reasoning is applied in the selection of the indicator; knowing the mortality rate of children under five it is possible to extrapolate their nutritional status.

The PCA analysis shows that there is also another component that results important as well explaining almost 26% of the variance (Table 11).

Figure 5: Utilization – Scree plot



The scree-plot (figure 5) clearly shows the presence of two principal components that explain the dimension with the second component being "Cereal waste" with which it has the highest correlation, 0.919 (Table 11).

Table 11: PCA analysis - correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component			
	1	2	3	4
Mortality under 5	,918	,275	-,170	,231
Life exp.	-,917	-,257	,207	,225
Prev. of undern.	,799	-,283	,531	-,009
Cereal waste	-,285	,919	,272	-,009

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

The high level of correlation of the indicator with the second component and the high percentage of variance explained by this component have induct the author to include the second component even if the dimension is associated to an eigenvalue lower than one, even if very close (Table 12)

Table 12: PCA analysis for utilization dimension: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,402	60,052	60,052	2,402	60,052	60,052
2	1,066	26,654	86,707	1,066	26,654	86,707
3	,428	10,690	97,397	,428	10,690	97,397
4	,104	2,603	100,000	,104	2,603	100,000

Extraction Method: Principal Component Analysis.

4.6 Stability

4.6.1. Theoretical framework

The stability dimension deals with the fact that people's food security situation may change over the time. Stability is underlined by the phrase "all people, at all times….." integral to the WFS definition of food security and is key to achieve national food security objectives. This dimension emphasizes the importance to reduce the risk of adverse effects on the other three dimensions: food availability, access or utilization. To be food secure, a population, household or individual must be guaranteed of availability of food, of access to adequate food and of its proper utilization at all times, in other words in a stable way.
Even if also adverse weather conditions and political instability may impact on the individual food security status, the common trend in studying this dimension at macro level is to focus on the availability and access dimension:often sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity) make availability and access at risk.

It was willing of the author to investigate the concept of stability in its broader definition, including therefore indicators on political stability, strength of legal rights and refugee population by country or territory of asylum. But unfortunately still those kinds of data are not registered for many countries and so they were excluded from the final selection of the indicators.

The selected indicators give a picture of the stability with respect to food availability and access in a country from 2 perspectives:

1) The composition of the food available in a country from its origin and its management:
   - Cereal Stock Variation
   - Import Dependency Ratio (IDR)
2) The variability, and so the dispersion from a central tendency, of 3 indicators measuring important consequences on food entitlement for the population:
   - Variability of food production index

- Variability of consumer price index
- Variability of harvested area

Cereal stock variation expresses in kg per capita changes in stocks occurring during the reference period at all levels between the production and the retail levels, i.e. it comprises changes in government stocks, in stocks with manufacturers, importers, exporters, other wholesale and retail merchants, transport and storage enterprises and in stocks on farms. No sign in data denotes net decreases from stock. This indicator, thus, can detect the change in the availability of stocks of food and therefore gives an immediate picture of the management of the stocks of cereal highlighting how much a country is able to face food deficiencies through its stocks.
The Import Dependency Ratio (IDR) provides information on how much of the available domestic food supply has been imported and how much comes from the country's own production. The IDR is calculated according to the international definition of the FAO as:

$$IDR = \frac{Imports * 100}{Production + Imports - Exports}$$

The complement of this ratio to 100 would represent that part of the domestic food supply that has been produced in the country itself while the result would provides information on the extent to which the country is dependent on import of foods.

As Sen argued (Sen, 1981) a person can be plunged into starvation either through a direct entitlement failure where there is less food produced for consumption or because the people can obtain less food through trade exchanging one's commodity for food facing, thus, a trade failure entitlement. Variability of food production index and variability of harvested area can be seen as indicator of direct entitlement failure, while variability on consumer price index is representative for trade failure entitlement.

Variability has been computed over a five years reference time period (so variability for 1995 takes into account data from 1991 to 1995 and so on) through the standard deviation. The next three indicators are expressed in term of their variability in order to underline the trends detected in the reference time period with respect to the mean of the period. This can give a picture of the volatility of a phenomenon in the time and by consequence of the stability.

Variability of food production index (1999-2001 = 100) expresses the trends in food production with respect to the reference year 1999 -2001. This indicator gives an immediate picture on the availability of food and first of all on the stability of the production. Data showing a high and negative variability show that the country is producing less quantities of food with respect to 1999 -2001 and therefore very probably this decrease in production can affect the households in several ways: through a minor supply in the markets, an increase in the prices of food, a strong utilization of the stock, etc.

Variability of consumer price index (2005 = 100) is a measurement of inflation and in particular of its changes in the time. If data show a high level of variability it is possible to deduce that the household's purchase power will be affected and very probably it will have consequences on the way income is spent and the quantities of products bought.

Variability of area harvested refers to the area from which a crop is gathered. Area harvested, therefore, excludes the area from which, although sown or planted, there was no harvest due to damage, failure, etc. This indicator gives an immediate picture of the quantities of area harvested and can be seen as a proxy to foresee the production quantities for a selected year. Assessments of area harvested can be helpful to detect same external conditions as weather shocks, migration flows, change in biodiversity etc that can affect the cultivation of lands.

4.6.2. Multivariate analysis

The PCA analysis highlights the presence of three prevalent dimensions which together explain about 74% of total variation (Table 15). The first dimension, which accounts for 30% of the variance, is described by Variability of harvested area, Variability of food production index and variability of consumer price index (Table 14). Import Dependency Ratio (IDR) contributes to the second component, which explains 23% of total variation and cereal stock variation represents to third component which explains 21% of total variation. From the analysis of the scree plot (Figure 5) it can be seen that the presence of one unique dimension cannot be fully supported in this case.

Table 13: Correlation matrix

Correlations

		Cereal stock variation	Var. of food prod. index	Var. of consumer price index	IDR	Var. of harvested area
Cereal stock variation	Pearson Correlation	1	-,161	,031*	,159	-,024
	Sig. (2-tailed)		,216	,810	,221	,855
	N	61	61	60	61	61
Var. of food prod. index	Pearson Correlation	-,161	1	,114	-,170	,028
	Sig. (2-tailed)	,213		,386	,191	,833
	N	61	61	60	61	61
Var. of consumer price index	Pearson Correlation	,031*	,114	1	,149	,186
	Sig. (2-tailed)	,810	,386		,259	,155
	N	61	61	61	61	61
IDR	Pearson Correlation	,159	-,170	,149	1	,154
	Sig. (2-tailed)	,221	,191	,259		,236
	N	61	61	61	61	61
Var. of harvested area	Pearson Correlation	-,024	,028	,186	,154	1
	Sig. (2-tailed)	,855	,833	,155	,236	
	N	61	61	61	61	61

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 6: Stability – Scree plot

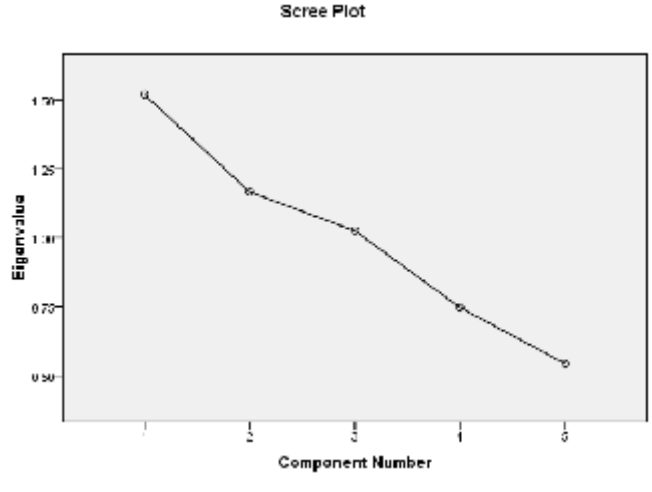


Table 14: PCA analysis - correlation coefficients between indicators and PCA components

Component Matrix[a]

	Component				
	1	2	3	4	5
Var. of consumer price index	,697	,435	-,304	-,031	-,482
Cereal stock variation	,685	-,214	-,514	-,153	,444
Var. of food prod. index	-,252	,822	-,213	,385	,279
Var. of harvested area	,385	,449	,661	-,422	,188
IDR	,601	-,231	,433	,630	,039

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Table 15: PCA analysis for stability dimension: explained variance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1,518	30,365	30,365	1,518	30,365	30,365
2	1,165	23,310	53,675	1,165	23,310	53,675
3	1,025	20,505	74,180	1,025	20,505	74,180
4	,747	14,939	89,120	,747	14,939	89,120
5	,544	10,880	100,000	,544	10,880	100,000

Extraction Method: Principal Component Analysis.

4.7. Normalization of data

Normalization is a kind of linear transformation. Normalization is necessary for any data aggregation as the indicators in a dataset have very frequently different measurement units and aggregation is meaningful only when indicators are comparable. There are a variety of normalization methods and the most frequently used in composite indicators are z-scores and min_max transformations (OECD, 2008).
For the Food Insecurity Multidimensional Index the min_max transformations, re-scaling, are adopted.

Standardization (or z-scores) converts indicators to a common scale with a mean of zero and standard deviation of one, re-scaling normalises indicators to have an identical range (0; 100). In order to compare dimensions and their indicators in time the min_max transformation has been preferred because with the z-score method the transformation is not stable when data for a new time point become available. This implies an adjustment of the analysis period, which in turn affects the mean and the standard deviation of the indicators and hence the values of the normalized indicator. To maintain comparability between the existing and the new data, the composite indicator for the existing data must be re-calculated.

4.7.1. Creating the dimension indicators

The first step is to create indicators for each dimension: minimum and maximum values (goalposts) need to be set in order to transform the indicators into indices between 0 and 100.
The goalposts are set to the observed minimum and maximum values of the indicators from the countries in the time series, that is, 1990–2010, in order to take into account the evolution of indicators. The goalposts are then applied to each dimension for the 4 five-years period (1995, 2000, 2005 and 2009) under analysis.

Table 16: Goalposts for the availability dimension

	MIN	MAX
Arable land	0,04	1,54
	Colombia, 2009	Niger, 1992
Cereal per yield	130,00	5524,30
	Botswana, 2000	China, 2008
Cereal domestic supply per capita	34,80	392,77
	Rwanda, 1998	Azerbaijan, 2009
Share of food aid	0,00	45,00
	Several countries, 1990	Armenia, 1990
Food supply	1337,17	3145,45
	Congo, Dem. Rep., 2009	Brazil, 2009
Permanent cropland	0,00	16,83
	Botswana, 1990	Philippines, 2009
Food production index	39,00	205,00
	Malawi, 1992	Sierra Leone, 2006
Land under cereal production per capita	0,00	0,91
	Jamaica, 2004	Niger, 1992

Table 17: Goalposts for the access dimension

	MIN	MAX
Consumer price index	0,01	331,47
	Brazil, 1991	Tajikistan, 2009
GDP per capita	78,01	11490,03
	Cambodia, 1990	Venezuela, 2009
Improved water source, % of rural population with access	12	104,3
	Ethiopia, 1995	Vietnam, 2009
Rural population	6,34	94,6
	Thailand, 2009	Rwanda, 1990

Table 18: Goalposts for the utilization dimension

	MIN	MAX
Cereal waste	0,17	67,59
	Congo, Dem. Rep.,1996	Paraguay 2007
Mortality rate, under-5	13,50	305,20
	Thailand, 2009	Niger, 1990
Prevalence of undernourishment	0,14	82,36
	Ghana, 2009	Congo, Dem. Rep., 2009

Table 19: Goalposts for the stability dimension

	MIN	MAX
Cereal stock variation	-152,00	134,00
	Tajikistan, 1992	Zimbabwe, 1995
Variability of food production index	0,01	22,86
	Bolivia, 2001	Senegal, 2009
Variability of consumer price index	0,89	43,60
	China, 2000	Venezuela, RB, 2009
IDR	0,02	99,60
	India, 2001	Botswana, 1998
Variability of area harvested	0,15	67,03
	Niger, 2005	Sudan, 1995

Min-Max normalises indicators in order to have an identical range (0, 100) by subtracting the minimum value and dividing by the range of the indicator values.

Having defined the minimum and maximum values, the indicators are calculated as follows:

Dimension index $= 100 * \left(\frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}} \right)$

4.7.2. Analysis of the outliers

In selecting the minima and maxima in order to normalize the dataset two countries have shown data non-consistent with the trend drawn by all other countries thus that could distort the transformed indicators and therefore must be considered outliers, they are:

1) Zimbabwe for Consumer Price Index (Access dimension) and Variability of Consumer Price Index (Stability dimension);

2) Jamaica for Import Dependency Ratio (Stability dimension).

Data for **"Consumer price index"** are published by the World Bank and the following table shows those one related to Zimbabwe for the time series considered:

Table 20: Data on Consumer price index for Zimbabwe:

Country Name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Zimbabwe	0,02	0,02	0,03	0,04	0,05	0,06	0,07	0,09	0,12	0,18

Country Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Zimbabwe	0,29	0,51	1,22	6,50	24,87	100,00	1.196,68	293.318,02	65.447,79	70.613,93

Consumer price index (CPI) is the main component from which inflation rates are derived and the incredible rise on CPI since 2006 shows that Zimbabwe is experiencing an important phenomenon of hyperinflation. A study conducted by the Department of Economics of the University of Pretoria in 2007 demonstrates that Food and Non-Alcoholic is the single component which command a very high weight in the country's CPI. Thus any larger proportionate increase (decrease) in this category will surely have a bigger positive (negative) effect on the inflation rate.
Hyperinflation in Zimbabwe began shortly after destruction of productive capacity in Zimbabwe's civil war and confiscation of white-owned farmland. Food output capacity fell 45%, manufacturing output 29% in 2005, 26% in 2006 and 28% in 2007, and unemployment rose to 80% (Marshall Auerback, 2010). During the height of inflation from 2008–09, it was difficult to accurately account and monitor for Zimbabwe's hyperinflation because the government of Zimbabwe stopped filing official inflation statistics. This cessation in filing made difficult to accurately observe how severe inflation was in the country (Hanke, Steve H; Alex KF Kwok The Cato Journal). In 2009 Zimbabwe abandoned its currency; at present in 2011 a new currency has yet to be introduced, so currencies from other countries are used.

For this reason data on CPI for Zimbabwe can be considered as outliers when taken into account with the data for all the other selected countries.
The selection of the minimum did not constitute a problem as the data shown by Brazil in 1991 is lower than the lowest data for Zimbabwe, but the problem came out in selecting the maximum value. The value presented by Zimbabwe in 2009 is largely too big with respect to the maxima data shown by the other countries thus the normalization would have been affected resulting in very small and close maxima value (because the denominator of the formula of normalization would have been very high with respect to the nominator). For this reason the maximum chosen is the second higher score of the time series corresponding to the data of Tajikistan for 2009.
Applying the formula of min_max the normalized indicator for Zimbabwe from 2006 to 2009 would have result in a number higher than 100, in order tc

with no meaning (indices are all between 0 and 100), the index 100 has been put by default.

Consequentially the same approach has been applied to the indicator on **"Variability of consumer price index".**

The values recorded from Jamaica in the time series for **"Cereal Import Dependency Ratio",** as shown in the table 21, indicate that since 1995 the values of export surpass those of production.

Table 21: Data on Cereals for Jamaica:

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Production	2.308	3.279	4.166	3.474	3.997	3.846	4.057	3.140	2.218	2.154
Import	335.368	445.191	450.404	452.462	363.076	438.210	308.002	459.737	459.241	458.425
Export	1.493	1.439	2.344	2.385	2.807	4.518	4.816	17.408	2.916	4.105
Export - Prod.	815	1840	1822	1089	1190	-672	-759	-14268	-698	-1951
% of (Export-Prod.)/Import						-0,15	-0,25	-3,10	-0,15	-0,43

	2000	2001	2002	2003	2004	2005	2006	2007
Production	1.777	2.072	1.752	2.038	1.598	1.928	1.895	1.675
Import	507.630	485.726	480.759	464.097	495.309	545.735	582.426	546.756
Export	4.617	7.025	5.430	6.303	14.171	9.276	6.289	9.050
Export - Prod.	-2840	-4953	-3678	-4265	-12573	-7348	-4394	-7375
% of (Export-Prod.)/Import	-0,56	-1,02	-0,77	-0,92	-2,54	-1,35	-0,75	-1,35

Jamaica has always been a net importer of cereals, as the data confirm, but since 1995 part of the imports seem to be re-exported, even if it must be recognized that the rate of imports re-exported is quite low (the maximum has been registered in 1997 with a share of 3,1%). The literature does not provide many explications about this phenomenon, the most corroborated is that Jamaica imports cereals and re-exports them as processed cereals.
Applying the formula of Import Dependency Ratio to Jamaica, the obtained values after 1995 are, for the reasons above explained, higher than 100 (the denominator, in fact, is lower than the numerator as the production values are inferior to the exports values).
For this reason in selecting the maximum value to apply to the data of all the countries, the second maximum was chosen and the value of 100 was applied by "default" as maximum for Jamaica for all five-years time series.

4.7.3. Inversing the indicators

Depending on the relation of the single indicators with the phenomenon to be measured it is necessary to decide which value of the single indicators has to be classified as "good" and which one has to be classified as "bad". (G. Lun et al., 2005)
The phenomenon analyzed is the vulnerability to food insecurity of a country, therefore the indicators expressing a "bad" situation, as the rate of mortality of children under 5 years old or the import dependency ratio are representatives of vulnerability to food insecurity. Thus higher is the rate of mortality in children under 5, higher is the vulnerability of the country, on the contrary, higher is the food supply, for example, lower is the risk of food insecurity in the country.
This classification is highly subjective, as in many cases, this is very difficult to judge. Additionally, this also depends a lot on the point of view of the individual taking the decision.

The single indicators are analyzed and those representing a dimension considered not "in the same direction" of the phenomenon are inversed:

$$100 - \frac{(\text{actual value} - \text{minimum value})}{(\text{maximum value} - \text{minimum value})} * 100$$

For each dimension all the indicators have been analyzed in order to decide if necessary to reverse some of them.

- **AVAILABILITY:**

All the indicators, a part from "Share of food aid" has been considered to express a "good situation" and therefore not a level of vulnerability to food insecurity.
In particular, "Arable land", "Permanent cropland", "Land under cereal production" can represent "good" signal of availability of food as input for food production; "Cereal domestic supply", "Food supply", "Cereal per yield" and "Food production index" are the "good" results, in terms of production and therefore of supply, of the inputs.
So those indicators have been reversed in order to unhide their complementary to 100 that is the "bad" part of the indicator.
Differently, "Share of food aid" represents a "negative" situation, as the countries with high values can be considered as more food insecure and therefore more needed for food aid.

- **ACCESS:**

For this dimension "GDP per capita" and "share of rural population with access to improved water" have been reversed.
There are no doubts that having the economic mean to buy food is a necessary even if not sufficient requirement in order to buy food. The importance of access to improved water is underlined in the same WFS definition of food security "…*access to sufficient, safe and nutritious food"* and food cannot be safe if not utilized with improved water.
"Consumer price index" and "Rural population", instead, are considered to express a possible area of vulnerability. High consumer price index in symptom of a high level of inflation that means that the value of money is not stable and therefore the household's purchasing power can vary, also a lot as in the discussed situation of Zimbabwe, and therefore not guarantee to the household access to sufficient food at all time. The indicator on water access is measured, by World Bank, in percentage of people with access over the total of rural population and expresses a "bad" situation. Therefore, for consistency, to belong to rural population is considered as expression of vulnerability. Is it possible to claim, that both, a high as well as a low value have to be regarded "bad", whereas a value in the middle could be considered "good". This would correspond to a so called U-shape optimum, but this study does not venture to this analysis.

- **UTILIZATION:**

The three indicators selected for this dimension, "Cereal waste", "Mortality rate of children under 5 years old" and "Prevalence of undernourishment" refer to "bad" situations: higher is the value of those indicators, higher is the vulnerability to food insecurity for the people of the country analyzed. For this reason the indicators were not reversed.

- **STABILITY:**
All the indicators of this dimension have not been reversed. Stability dimension is represented by three indicators on variability and ,as this shows the extent to which single values, for each year and each country, diverge from a mean, an increase of variability can be understood as an increase in divergence so a characteristic of instability.
The indicator "Import Dependency Ratio" as the name suggests, records how much food is imported in the country so gives a signal of food insecurity: more food is imported, instead of produced, more the country is vulnerable from a food security perspective.
The analysis of cereal stock variation has been a bit more complex as the signs of the values must be interpreted on the contrary as usual: a " –" sign shows an increase in stocks, while a "+" sign a decrease in stocks. The utilization of signs done by FAO in publishing the data underlines that the focus, in recording cereals stocks variation, is on the decrease of stocks, so the indicator records a "bad" situation according positive sign and therefore is "in the same direction" of the phenomenon under analysis.

4.8. Aggregation of data

The final synthetic index on food insecurity is built through two different aggregations:

1) Aggregation of indicators for each dimension of food insecurity;
2) Aggregation of the four dimensions.

4.8.1. Aggregation of indicators

Most composite indicators rely on equal weighting (EW), *i.e.*, all variables are given the same weight. This could correspond to the case in which all variables are "worth" the same in the composite and in any case, equal weighting does not mean "no weights", but implicitly implies the weights are equal. The studies on statistical correlation, through the Pearson correlation coefficient, allow to avoid to combine variables with high degree of correlation and to introduce elements of double counting into the index.

The aggregation of indicators has been computed for:
- each dimension;
- each country;
- each "five years period".

A linear aggregation, as a simple arithmetic mean, has been used as all individual indicators have the same measurement unit and the compensability of indicators per dimension is considered acceptable: so a deficit in one indicator can thus be offset (compensated) by a surplus in another. Compensability has been accepted in this aggregation as the indicators are all, even if in different way, expression of the same dimension, so no hierarchy exists among the different indicators.

After the aggregation of indicators for dimension it is possible to compute the synthetic index of each pillar of food security for each cou
indexes" capture the contribution of each dimension to the

insecurity uncovering how much each single pillar weight in the final index and which dimension contributes more to the total vulnerability of a country.

The results of the aggregation per dimension will be deeper discussed in the next chapter.

4.8.2. Aggregation of dimensions

Finally the indexes for each dimension are aggregated, for each country and each reference period, through a power mean. While the four dimensions of food insecurity are all important, it is not unreasonable to assume, given their dissimilarity, that the relative impact of the vulnerability of each would increase as the level of vulnerability becomes sharper. Literature confirms that a power (or generalized) mean of order greater than one is very useful when we wish to build composite indices of poverty or of risk in general. This mean «places greater weight on those dimensions in which deprivation is larger» (Anand and Sen, 1997, p. 16). This study follows Sen's suggestion to choose power = 3 as it places grater weight on those dimensions in which deprivation is larger (Anand and Sen, 1997, p. 16).

The formula used to compute the FIMI, for country *i*, is:

$$FIMI = (1/4(AV_i^3 + AC_i^3 + UT_i^3 + ST_i^3)^{1/3}$$

The synthetic index of food insecurity allows to rank all the countries for each reference period in order to track changes in country performance over time. The results will be deeply discussed in the next chapter.

5. FIMI: RANKING AND TRENDS

In this chapter FIMI scores will be analyzed, under different perspectives, with the support of the "Food Insecurity Map" (figures 7 and 8) underlying the root causes of food insecurity within the countries under study.
While FIMI can be used as summary indicator to guide policy and data work, it can also be decomposed such that the contribution of individual dimension can be identified and the analysis of country performance can be extended to an investigation on the dimensions that more affect the overall index.
FIMI scores can also reveals the trends in food insecurity for countries and can be aggregated to analyze regional trends from geographic of view, thus the analysis will be conducted at both country and geographical level.

5.1 FIMI Maps – General analysis

As already mentioned, FIMI can take scores from 0 (best case) to 100 (worst case).
FIMI has been calculated for 61 countries covering the period among 1990 and 2009 through 4 series of five years, the maps for 1995 and 2009 are here presented and generally analysed.
The international ranking ranges from a minimum FIMI score of 30,72 (Brazil 2009) to a maximum score of 64,07 (Ethiopia 1995) covering about 33 FIMI points, the mean FIMI score is 49,03.
The Food Insecurity Maps have been drawn in order to set the intensity of the phenomenon depending on the FIMI scores and foresee 4 thresholds, roughly classified:

1) 30 < FIMI < 39,99 MODERATE FOOD INSECURITY
2) 40 < FIMI < 49,99 SERIOUS FOOD INSECURITY
3) 50 < FIMI < 59,99 ALARMING FOOD INSECURITY
4) FIMI > 60 EXTREMELY ALARMING FOOD INSECURITY

The **FIMI map 2009** in Figure 7 clearly shows that the **hot spots of food insecurity are in East and Central – Southern Africa**. There are few exceptions to this rule: Gambia and Cote d'Ivoire in West Africa, Yemen in the Near East; Tajikistan in Central Asia and Mongolia in Southeast Asia also have FIMI scores higher than 50. The significant lack of food availability and access, combined with an instable general situation are the major reasons for widespread food insecurity (Table 24).

However, a comparison of FIMI scores for 2009 with FIMI scores for 1995 (see the FIMI map for 2009 in figure 7 and the FIMI map for 1995 in Figure 8, and table 22) illustrates considerable progress in this decade: the number of countries facing an extremely alarming situation of food insecurity decreased from 3 in 1995 to 1 in 2009 and more positive are the changes in countries with FIMI scores indicating an alarming situation, in the period covered they diminished from 35 to 21. Most of those progresses were shifted towards the moderate level that in 2009 accounted for 13 countries instead of only 1 in 1995. The number of countries that present a serious level of food insecurity have risen in the period, from 22 to 26, however this should be taken as positive considering the decrease in the al

Some countries and even entire regions are on track to escape the vicious cycle of poverty and hunger. Examples are large parts of the Andean region in South America and in Central America and Caribbean, several West and Central African countries like Mali, Burkina Faso, Benin and Nigeria, and also some East and Southern African countries with high FIMI scores, but recent reductions in food insecurity (e.g., Ethiopia, Mozambique, and Burundi, where major wars have come to an end). Positive trends can be observed throughout most of South and Southeast Asia, including China, Vietnam and Philippines. Regional and country trends are addressed in more detail in the following section.

5.2 FIMI Ranking – Analysis at country level

The Food Insecurity Multidimensional Index will be discussed above all in terms of ranking for 2009 (table 22) and comparison of ranks between 2009 and 1995 (table 23) underlying the changes in the dimensional sub-indexes occurred in the time (table 24).

Brazil is far at the bottom of the list with a FIMI of 30,72 the following country, **Philippines**, is away of 5 points and closely followed by **China, Dominican Republic and El Salvador**. The top-five ranking remains basically unchanged over all the time series under analysis with exception from China that improved its vulnerability to food insecurity of 8 positions reflecting the extraordinary overall development that the country is facing since the 80's (also thanks to the Deng Xiao Ping reform and open door policies which opened up the Chinese economy to the rest of the world).

Extending the perimeter to the top- ten ranking is it possible to notice that still the majority of the countries are the same with the exception of Azerbaijan and Vietnam that, respectively, gained 26 positions (from 30th position in 1995 to the 56th in 2009) and 14 positions (from 41 to 55 in 2009).

The biggest improvement for **Azerbaijan** has been registered between 1995 and 2005 in fact the overall index passes from 52,21% to 40,41. This result should be read in conjunction with the one shown by Armenia. This latter, in fact, also recorded a positive performance going from the 16the position to the 47the in the time reference considered and, in particular, the bigger improvement in food security was achieved between 2000 and 2005. For both countries the six-year war (1988 – 1994) over the disputed enclave of Nagorno-Karabakh Caucasian conflict has represented the main cause of vulnerability as some 1 million people had been forced from their homes as refugees and internally displaced people (UNHCR, 1996).
In Azerbaijan the agricultural sector experienced enormous difficulties, over the beginning of the 90's and availability, access and stability were deeply compromised. Traditional trading arrangements for agricultural products, as for other products, collapsed with the break-up of the Soviet Union. The military conflict over Nagorno-Karabakh left much of Azerbaijan's fertile land under occupation. Crop production in Azerbaijan heavily depends on irrigation and this was significantly deteriorated. Declines in food production and in the population's purchasing power have jeopardized food security for many people in Azerbaijan leaving most people able to afford only the barest essentials with natural implication on nutrition, particularly among children and vulnerable groups (United Nations Country Team Azerbaijan Republic 2001). Improvements in food security have been possible t

implementation of international aid programs. Azerbaijan, in fact, has been the country which received the greatest amount of support from the EU among the three South Caucasian countries. Since regaining independence, in 1991, Azerbaijan has received by European Commission as total assistance some 400 million euros, (Nuriyev, 2007) and the first Food Security Program started in 1996 and has been implemented through the national budget since 1997. Those economics efforts are reflected in the amelioration of the indicators for dimension: availability sub index shifted from 67,17% in 1995 to 47,24, access from 55,47% to 51,57% and stability from 45,17& to 28,31%.
As a consequence of its isolation resulting from the Nagorno-Karabakh context, Armenia has not fully benefited so far from EU-supported regional Program and probably also for this reasons shows a fewer improvement in the dimensions of food security, even if still positive.

In the time covered **Vietnam** moved of 14 positions to hold the 55th position in 2009. In Vietnam reforms of the economic system have resulted in a spectacular improvement of food security during the past decade reflected by the Food Insecurity Multidimensional Index that was of 48,52% in 1995 and of 38,25% in 2009. This achievement is impressive considering that the country was largely affected by a food shortage in 1988 and is due mainly to the inception of Doi Moi in 1986 and the de-collectivization of agriculture in 1988 (Bergeret, 2002). The lesson of the last decade of Vietnam's experience is that improvements in the agricultural sector in general and food production in particular led to overall improvements in food availability and food consumption across different income groups captured by the dimensional indexes: Availability index in 1995 was at 59% and access at 61,31% while in 2009 they were, respectively, of 39,10% and 52,80%. Access, still represents an important goal to be fully achieved, but it is necessary to take into consideration that Vietnam is still among the lowest income countries.

Peru's success in improving food security during 1995-2005 was impressive, in fact FIMI passed from 50,23% in 1995 (38th position) to 39,70% in 2009 but the biggest improvement was registered between 1995 and 2005. Peru's success in food security can be attributed to political stability that was a result of the combination of the peace found after the conflict with Sendero Luminoso (1980 – 1992) and a newly instituted set of macroeconomic policies: stability dimension registered high value in 1995, 42,67% impressively diminished in 2005 with a value of 28,34% (USDA 2005).

Rising in ranks, **Nicaragua** at 38th position in 2009 has registered an important amelioration in terms of overall index going from 52,74 in 1995 to 44,82 in 2009 gaining 13 positions. Most of the improvement is performed between 1995 and 2000, thanks to the rising in availability of food (from 74,9% to 64,8%) but it is interesting to note that this amelioration in availability is not supported by an increase in stability, that on the contrary, shows for 2000 a worsening of the situation. The political instability (under the Sandinista National Liberation Front) and the uncertainty linked to the weather conditions with no doubt contribute to the vulnerability of the country (USAID 2005), but the access dimension driven by the indicator on GDP per capita clearly shows that Nicaragua faces an impressive problem of food access (that, in fact, presents in both periods very high values).

Despite that among the middle bottom part of the ranking, from Brazil to Pakistan, only six has significantly changed their ranking from 1995 to 2009 and that from those six countries, five moved towards a better perforn

Pakistan registered a sharp worsening in the FIMI ranking. It is interesting to note that in 1995 Pakistan hold the 44th position with a FIMI index of 47,78 and in 2009 the registered value of 47,03 corresponded to the 32th position. This data can be read in two complementary ways: in the reference period most of the countries have registered a lower index of food insecurity, in fact the minimum value decreases from 37,62% to 30,72% therefore other countries have overtaken Pakistan and so, in this context, the stability of the Pakistan index is a signal of weak capacity to change the state of food security within the country. This no-change is captured by all the dimensional indexes, in fact the values reported for 1995 are quite identical to those one of 2009. According to M. Arif (Agriculture and food Security in Pakistan), the rural poverty rates in 2004-05 were still at levels approximating those of the 1990s and the longer term agricultural GDP per capita growth rate (1999-2000 to 2004-05) was only 0.3 percent annually. In this five year period Pakistan ranking of food insecurity shifted from the 41th position to the 35th mostly for the effect of stability dimension probably driven by the fluctuations/shortages in food grains production and their prices caused by the severe droughts occurred in 2000.
Analyzing the middle up part of the ranking is it possible to see that over 31 countries only eight significantly changed their position between 1995 and 2009 and in particular five of them presented, at the end of the period covered, a higher index of food insecurity, therefore they showed a worsening in performance of food security and three an amelioration. The 'bad performers' are: Botswana, Tanzania, Mongolia, Kenya and Burundi, while the 'good' are: Mali, Malawi and Rwanda.

Table 22: Food Insecurity Multidimensional Index – Rank of countries

FIMI Rank	Country	Food insecurity Multidimensional Index			
		1995	2000	2005	2009
1	Congo, Dem. Rep.	56,97	58,44	61,06	**63,83**
2	Ethiopia	64,07	60,50	58,42	**59,86**
3	Zimbabwe	58,18	50,00	53,56	**59,33**
4	Tajikistan	59,21	57,65	53,93	**58,90**
5	Mozambique	62,00	57,88	57,78	**57,13**
6	Burundi	52,42	54,18	54,24	**56,51**
7	Sierra Leone	56,27	61,16	58,34	**55,96**
8	Kenya	54,72	55,16	54,68	**55,90**
9	Madagascar	54,93	54,84	54,75	**55,42**
10	Yemen, Rep.	54,38	53,70	55,34	**55,13**
11	Chad	58,96	57,60	55,55	**55,00**
12	Mongolia	51,02	51,63	53,81	**54,64**
13	Zambia	55,77	53,90	55,35	**54,44**
14	Central African Republic	56,48	54,96	54,54	**54,41**
15	Lesotho	56,31	52,59	53,21	**53,89**
16	Tanzania	52,60	53,29	53,28	**53,81**
17	Rwanda	63,12	59,81	53,17	**53,62**
18	Senegal	52,82	52,56	51,06	**52,84**
19	Niger	55,67	54,09	52,21	**51,34**
20	Sudan	54,27	51,94	50,19	**50,83**
21	Uganda	52,51	52,30	51,41	**50,68**
22	Malawi	57,50	53,43	54,27	**50,09**
23	Botswana	47,50	50,80	50,37	**48,92**
24	Cambodia	55,76	53,80	50,51	**48,61**
25	Mali	56,05	54,08	51,46	**48,60**
26	Gambia, The	51,71	49,42	49,66	**48,17**
27	Nigeria	50,88	49,67	48,85	**47,94**
28	Nepal	50,36	49,31	47,96	**47,79**
29	Cameroon	53,31	51,27	49,39	**47,68**
30	Benin	53,24	50,52	48,78	**47,38**
31	Burkina Faso	53,56	52,32	49,07	**47,15**
32	Pakistan	47,78	46,76	46,84	**47,03**
33	Namibia	50,93	50,16	48,04	**46,26**
34	Lao PDR	52,68	52,10	48,90	**46,23**
35	India	48,04	47,48	46,93	**45,95**
36	Bangladesh	50,83	48,00	46,08	**45,63**
37	Cote d'Ivoire	48,16	46,90	45,59	**45,30**
38	Nicaragua	52,74	48,76	46,04	**44,82**
39	Sri Lanka	45,58	44,48	44,16	**44,33**
40	Bolivia	50,91	48,24	45,70	**44,19**
41	Guatemala	46,85	45,51	45,07	**44,14**
42	Honduras	46,98	47,44	46,71	**44,00**
43	Uzbekistan	45,27	45,63	43,27	**43,61**
44	Jamaica	49,42	43,88	42,77	**43,51**
45	Ghana	49,25	46,28	44,73	**43,19**
46	Paraguay	45,53	45,32	44,06	**43,00**
47	Armenia	55,16	51,83	45,00	**41,17**
48	Venezuela, RB	41,60	40,80	40,93	**41,06**
49	Thailand	42,26	42,99	41,55	**39,81**
50	Peru	50,23	45,93	42,87	**39,70**
51	Colombia	43,44	42,29	41,15	**39,40**
52	Ecuador	44,47	44,35	41,40	**39,23**
53	Panama	44,92	43,59	41,05	**39,09**
54	Indonesia	41,86	42,22	40,79	**38,88**
55	Vietnam	48,52	44,47	40,66	**38,25**
56	Azerbaijan	52,21	46,27	40,41	**38,18**
57	El Salvador	43,33	40,46	39,44	**37,46**
58	Dominican Republic	40,79	39,11	40,43	**37,28**
59	China	45,13			
60	Philippines	40,25			
61	Brazil	37,62			

Table 23: Food Insecurity Multidimensional Index – Comparison of ranks

FIMI Rank	Country	Comparison of ranks				
		2000/1995	2005/2000	2009/2005	2009/1995	
1	Congo, Dem. Rep.	-4	-3	0	-7	
2	Ethiopia	1	0	0	1	≈
3	Zimbabwe	25	-16	-12	-3	
4	Tajikistan	2	7	-9	0	≈
5	Mozambique	2	-1	1	2	
6	Burundi	-18	1	-6	-23	≠
7	Sierra Leone	-10	2	4	-4	
8	Kenya	-10	1	-1	-10	≠
9	Madagascar	-7	-2	1	-8	
10	Yemen, Rep.	-3	-9	3	-9	
11	Chad	2	-2	6	6	
12	Mongolia	-6	-12	-2	-20	≠
13	Zambia	1	-8	7	0	≈
14	Central African Republic	0	1	4	5	
15	Lesotho	9	-2	-2	5	
16	Tanzania	-9	-2	0	-11	≠
17	Rwanda	1	15	-1	15	≠
18	Senegal	-4	2	-4	-6	
19	Niger	-3	7	0	4	
20	Sudan	4	1	-5	0	≈
21	Uganda	-6	-1	0	-7	
22	Malawi	10	-6	11	15	≠
23	Botswana	-17	-4	-1	-22	≠
24	Cambodia	1	8	1	10	
25	Mali	1	7	5	13	≠
26	Gambia, The	2	-7	0	-5	
27	Nigeria	-3	-2	-3	-8	
28	Nepal	-3	-1	-5	-9	
29	Cameroon	5	0	2	7	
30	Benin	6	2	-1	7	
31	Burkina Faso	0	7	3	10	
32	Pakistan	-3	-6	-3	-12	≠
33	Namibia	-3	2	1	0	≈
34	Lao PDR	-3	6	5	8	
35	India	-5	-4	1	-8	
36	Bangladesh	1	0	-1	0	≈
37	Cote d'Ivoire	-2	0	-3	-5	
38	Nicaragua	10	3	0	13	≠
39	Sri Lanka	0	-4	-5	-9	
40	Bolivia	2	3	1	6	
41	Guatemala	-1	-5	0	-6	
42	Honduras	-7	-3	6	-4	
43	Uzbekistan	-5	1	-3	-7	
44	Jamaica	12	-3	-4	5	
45	Ghana	2	1	2	5	
46	Paraguay	-2	-2	1	-3	
47	Armenia	9	17	5	31	≠
48	Venezuela, RB	-1	-4	-5	-10	
49	Thailand	-3	-4	0	-7	
50	Peru	6	3	3	12	≠
51	Colombia	1	-4	0	-3	
52	Ecuador	-3	0	2	-1	≈
53	Panama	0	0	1	1	≈
54	Indonesia	-1	-2	0	-3	
55	Vietnam	8	6	0	14	≠
56	Azerbaijan	13	14	-1	26	≠
57	El Salvador	3	0	-1	2	
58	Dominican Republic	0				
59	China	3				
60	Philippines	0				
61	Brazil	0				

≈ No changes or shifting of +-1 position, in the comparison of ranks between 2009/1995 ≠ Relevante changes of positions, in the co

Table 24: Food Insecurity Multidimensional Index – Weight of dimensions

Country	1995					2000					2005					2009				
	FIMI	AV	AC	UT	ST	**FIMI**	AV	AC	UT	ST	**FIMI**	AV	AC	UT	ST	**FIMI**	AV	AC	UT	ST
Armenia	**55,16**	78,70	43,42	27,72	44,60	**51,83**	75,40	44,09	25,07	32,23	**45,00**	60,65	41,73	25,09	38,50	**41,17**	54,97	38,26	24,31	35,75
Azerbaijan	**52,21**	67,17	55,47	21,58	45,17	**46,27**	59,87	54,07	15,94	28,85	**40,41**	47,24	51,57	11,44	28,37	**38,18**	44,24	45,34	7,45	35,53
Bangladesh	**50,83**	67,24	57,14	32,98	17,06	**48,00**	60,50	57,47	29,33	22,34	**46,08**	55,88	58,22	24,61	20,97	**45,63**	53,13	59,66	21,98	22,61
Benin	**53,24**	66,22	59,87	40,17	34,47	**50,52**	62,50	58,94	39,26	23,26	**48,78**	60,18	57,36	36,73	23,86	**47,38**	59,65	54,86	34,17	23,61
Bolivia	**50,91**	70,55	52,66	25,44	27,38	**48,24**	66,32	51,53	22,94	23,90	**45,70**	62,04	49,97	20,27	24,21	**44,19**	60,46	47,26	18,36	25,41
Botswana	**47,50**	67,85	38,68	22,03	37,53	**50,80**	71,53	38,78	23,84	45,27	**50,37**	70,62	34,67	19,86	48,69	**48,92**	71,02	36,37	19,85	39,06
Brazil	**37,62**	53,38	32,02	23,24	26,11	**36,84**	52,65	33,52	19,19	22,62	**34,72**	47,86	31,31	18,54	28,23	**30,72**	44,00	22,23	20,76	22,90
Burkina Faso	**53,56**	61,31	69,02	36,33	24,65	**52,32**	61,87	66,36	33,34	23,99	**49,07**	55,97	63,84	32,88	19,33	**47,15**	54,64	59,61	31,14	26,75
Burundi	**52,42**	64,91	61,02	40,78	24,42	**54,18**	67,02	63,56	42,20	22,16	**54,24**	64,70	65,33	44,00	22,39	**56,51**	66,45	68,58	45,22	28,04
Cambodia	**55,76**	65,36	70,93	37,27	24,07	**53,80**	62,49	69,72	34,05	20,15	**50,51**	54,14	67,07	34,46	27,26	**48,61**	49,98	65,91	33,09	25,97
Cameroon	**53,31**	68,40	61,63	31,77	30,07	**51,27**	65,49	59,60	30,46	29,12	**49,39**	63,89	57,07	29,57	24,74	**47,68**	63,03	54,32	27,52	19,16
Central African Republic	**56,48**	73,62	62,10	38,82	31,94	**54,96**	71,34	62,23	38,45	22,24	**54,54**	70,61	62,44	37,41	20,81	**54,41**	70,06	63,10	36,23	21,22
Chad	**58,96**	71,06	68,17	50,93	28,11	**57,60**	69,04	68,21	48,05	25,32	**55,55**	64,14	67,52	48,63	19,26	**55,00**	63,84	67,30	46,52	19,88
China	**45,13**	52,33	59,13	19,69	24,25	**42,51**	50,06	55,82	16,29	19,10	**39,42**	47,36	51,13	10,78	18,86	**35,24**	44,59	43,35	9,10	18,23
Colombia	**43,44**	63,14	38,14	8,24	28,80	**42,29**	59,47	40,28	7,01	31,04	**41,15**	57,79	39,41	6,00	30,16	**39,40**	55,20	36,42	5,26	31,31
Congo, Dem. Rep.	**56,97**	71,82	64,32	38,15	38,45	**58,44**	74,19	64,89	44,04	34,48	**61,06**	74,64	70,55	49,87	31,37	**63,83**	76,51	73,81	54,55	34,41
Cote d'Ivoire	**48,16**	64,17	54,06	23,84	25,28	**46,90**	61,73	54,60	22,48	20,01	**45,59**	58,97	54,23	20,85	21,46	**45,30**	58,75	53,64	19,24	22,81
Dominican Republic	**40,79**	55,52	40,42	16,70	31,95	**39,11**	53,74	37,93	16,00	30,40	**40,43**	51,26	38,28	14,90	41,84	**37,28**	49,48	36,31	14,34	33,47
Ecuador	**44,47**	64,44	41,39	14,36	24,23	**44,35**	61,80	43,19	13,05	32,42	**41,40**	58,97	39,95	11,80	25,54	**39,23**	56,42	35,56	11,49	26,25
El Salvador	**43,33**	57,46	49,24	13,56	26,00	**40,46**	52,61	46,54	11,43	27,14	**39,44**	51,43	44,61	10,29	28,08	**37,46**	48,70	41,97	10,07	28,03
Ethiopia	**64,07**	76,34	77,97	48,04	32,92	**60,50**	71,84	76,54	40,91	20,77	**58,42**	67,10	76,07	34,90	28,34	**59,86**	63,87	81,09	29,21	36,85
Gambia, The	**51,71**	71,58	51,58	27,60	32,58	**49,42**	65,00	49,22	28,24	41,64	**49,66**	66,10	49,08	27,26	40,90	**48,17**	63,32	46,81	25,24	43,03
Ghana	**49,25**	64,08	56,04	27,27	28,95	**46,28**	59,95	54,23	22,64	24,37	**44,73**	53,82	54,46	17,67	33,96	**43,19**	48,98	52,93	12,87	38,69
Guatemala	**46,85**	65,89	46,53	14,49	29,77	**45,51**	64,37	45,94	13,37	24,84	**45,07**	61,24	45,60	13,99	35,08	**44,14**	59,11	44,30	14,39	37,22
Honduras	**46,98**	64,45	51,50	15,73	22,54	**47,44**	64,48	51,23	13,35	30,12	**46,71**	59,33	51,18	12,33	40,77	**44,00**	58,33	49,75	10,76	27,96
India	**48,04**	63,12	56,66	21,45	17,59	**47,48**	61,99	56,73	20,06	16,16	**46,93**	61,61	55,75	18,23	17,19	**45,95**	59,84	54,87	17,46	19,73
Indonesia	**41,86**	51,53	52,08	19,85	22,19	**42,22**	51,79	52,98	18,33	22,06	**40,79**	48,29	52,05	17,03	25,18	**38,88**	44,96	50,53	16,59	23,69
Jamaica	**49,42**	68,69	39,29	8,12	46,94	**43,88**	59,75	38,38	7,50	41,52	**42,77**	57,81	39,51	6,45	39,42	**43,51**	55,87	42,45	6,23	43,49
Kenya	**54,72**	69,35	66,99	26,24	22,18	**55,16**	70,24	67,01	24,17	26,14	**54,68**	68,75	67,48	22,91	25,92	**55,90**	68,51	69,59	22,05	33,59
Lao PDR	**52,68**	66,24	64,78	28,43	**18,45**	**52,10**	60,49	66,81	26,16	**32,70**	**48,90**	54,99	65,98	24,13	**17,75**	**46,23**	51,71	62,66	22,55	**15,90**
Lesotho	**56,31**	69,39	63,38	22,88	**49,62**	**52,59**	66,16	60,11	31,00	**37,37**	**53,21**	64,89	58,01	32,72	**47,40**	**53,89**	67,35	56,75	28,33	**49,68**
Madagascar	**54,93**	66,57	69,49	32,44	18,51	**54,84**	66,97	69,78	28,09	17,39	**54,75**	64,08	71,48	27,29	25,04	**55,42**	65,54	72,55	24,46	22,32
Malawi	**57,50**	73,29	64,72	45,79	20,78	**53,43**	64,73	63,40	40,63	29,05	**54,27**	68,43	63,16	34,00	32,81	**50,09**	62,45	60,19	29,96	27,15
Mali	**56,05**	64,00	70,77	43,79	23,15	**54,08**	62,09	69,08	39,16	22,41	**51,46**	57,27	67,14	36,44	23,32	**48,60**	50,58	64,37	33,93	30,81
Mongolia	**51,02**	66,90	56,96	22,38	34,79	**51,63**	66,95	58,34	18,65	37,33	**53,81**	72,58	57,08	14,89	38,95	**54,64**	67,93	56,40	12,90	54,89
Mozambique	**62,00**	80,95	67,48	45,90	31,27	**57,88**	73,36	67,76	40,80	22,38	**57,78**	72,00	69,17	35,56	31,65	**57,13**	70,43	70,73	31,23	27,76
Namibia	**50,93**	67,00	53,08	23,94	41,32	**50,16**	66,18	52,04	21,70	41,15	**48,04**	67,16	47,42	17,53	32,31	**46,26**	64,81	43,37	14,64	35,18
Nepal	**50,36**	64,11	59,70	32,36	18,77	**49,31**	62,42	59,86	28,25	17,11	**47,96**	60,12	59,34	24,71	17,22	**47,79**	59,06	60,00	21,64	21,25
Nicaragua	**52,74**	74,93	49,49	29,45	29,74	**48,76**	64,83	51,45	25,70	35,17	**46,04**	60,17	51,83	21,60	30,29	**44,82**	57,06	53,18	18,97	27,71
Niger	**55,67**	50,52	71,93	56,92	23,47	**54,09**	50,43	72,17	48,33	28,64	**52,21**	47,91	72,28	43,46	18,51	**51,34**	43,51	72,15	38,01	32,69
Nigeria	**50,88**	61,26	61,50	38,64	23,42	**49,67**	60,68	60,99	33,57	19,89	**48,85**	57,22	61,83	29,66	28,01	**47,94**	55,32	62,04	26,21	27,04
Pakistan	**47,78**	65,57	51,51	23,90	20,92	**46,76**	63,43	52,22	22,78	16,22	**46,84**	63,20	52,77	21,76	18,33	**47,03**	60,97	55,39	20,97	24,66
Panama	**44,92**	64,29	44,01	11,23	24,33	**43,59**	63,05	39,00	10,26	28,83	**41,05**	59,95	34,47	9,47	28,19	**39,09**	57,06	28,33	8,83	31,90
Paraguay	**45,53**	59,23	54,50	17,59	18,98	**45,32**	59,54	52,58	14,53	25,80	**44,06**	56,53	51,09	16,47	30,26	**43,00**	51,39	46,03	37,93	32,35
Peru	**50,23**	69,05	46,50	17,69	42,67	**45,93**	62,43	47,66	14,67	33,40	**42,87**	58,53	45,40	12,49	28,34	**39,70**	53,58	40,92	10,52	30,89
Philippines	**40,25**	54,11	45,19	13,42	22,01	**38,69**	50,87	44,70	11,41	22,80	**36,94**	47,34	44,07	9,97	22,32	**35,03**	44,53	42,21	8,82	21,27
Rwanda	**63,12**	71,65	63,67	46,68	66,25	**59,81**	79,61	63,67	36,78	37,84	**53,17**	65,79	64,84	30,61	28,12	**53,62**	64,44	68,41	26,03	26,47
Senegal	**52,82**	67,31	61,50	32,94	28,51	**52,56**	65,77	61,42	28,89	36,23	**51,06**	64,17	60,21	26,45	33,61	**52,84**	62,22	59,30	21,90	51,57
Sierra Leone	**56,27**	69,44	56,51	52,26	39,89	**61,16**	72,90	58,96	46,67	61,48	**58,34**	63,12	67,60	44,54	53,78	**55,96**	58,69	74,14	42,35	28,84
Sri Lanka	**45,58**	54,67	58,10	15,26	27,20	**44,48**	52,65	57,46	13,45	26,17	**44,16**	50,56	57,74	12,46	29,09	**44,33**	49,00	57,29	10,94	35,67
Sudan	**54,27**	68,93	55,96	28,54	49,45	**51,94**	67,36	59,27	25,81	32,98	**50,19**	62,77	60,02	25,33	31,70	**50,83**	64,76	62,06	22,99	20,61
Tajikistan	**59,21**	71,04	59,11	27,44	63,39	**57,65**	72,45	66,41	24,90	44,31	**53,93**	64,70	63,80	22,87	45,22	**58,90**	61,47	77,73	20,65	48,88
Tanzania	**52,60**	65,13	64,81	32,47	18,63	**53,29**	65,25	66,65	30,70	21,26	**53,28**	63,50	67,63	31,67	24,69	**53,81**	62,90	70,12	30,68	20,15
Thailand	**42,26**	54,35	45,81	32,71	23,94	**42,99**	54,04	47,84	36,97	15,29	**41,55**	52,67	46,21	34,49	16,35	**39,81**	51,11	42,95	32,86	19,16
Uganda	**52,51**	61,08	68,36	29,50	23,59	**52,30**	60,49	67,69	27,44	30,01	**51,41**	58,58	67,00	26,02	31,31					
Uzbekistan	**45,27**	60,15	48,28	10,16	35,38	**45,63**	62,09	51,06	10,22	22,14	**43,27**	53,84	53,69	9,97	25,19					
Venezuela, RB	**41,60**	62,36	28,65	15,75	27,71	**40,80**	60,08	26,90	13,97	32,92	**40,93**	59,39	29,04	13,17	34,51					
Vietnam	**48,52**	59,00	61,31	24,89	22,18	**44,47**	51,83	58,20	22,83	19,63	**40,66**	43,40	55,60	21,27	20,62					
Yemen, Rep.	**54,38**	72,21	59,04	26,06	37,11	**53,70**	70,57	59,69	24,58	36,30	**55,34**	71,83	61,85	22,33	40,73					
Zambia	**55,77**	72,45	61,58	36,52	34,18	**53,90**	68,86	62,65	36,11	24,26	**55,35**	68,45	64,83	36,03	36,00					
Zimbabwe	**58,18**	73,50	50,69	32,52	61,77	**50,00**	65,90	50,01	32,11	39,48	**53,56**	68,79	56,84	26,42	45,52					

AV = Availability ; AC = Access ; UT = Utilization ; ST = Stability

Following the ranking from the bottom to the top, **Mali** is ranked at the 25th position in 2009 with an index of 48,6, gaining 13 positions since 1995 (FIMI of 56,05). The improvement in the overall index is mainly driven by constant progresses in the availability and utilization dimension that, respectively, go from 64% in 1995 to 50,58% in 2009 and from 43,79% to 33,93. The indicators of availability show a massive increase in food availability both in terms of cereal per year and food production that are reflected in a higher amount of calories supplied (food supply) and as a consequence in a decrease of undernourishment. Those data are confirmed by the OECD document 'Agricultural Progress in Cameroon, Ghana and Mali: Why it Happened and How to Sustain It'. Since the mid-1980s food crop production has more than kept up with population growth fuelling significant increases in per capita food availability. A frequently expressed concern is that, where it occurs, growth in African agricultural production comes mainly from increases in the area of land cultivated - not from increases in yields or from gains in factor productivity. Prior to the mid-1980s, growth in food crop production in Mali was sluggish and in fact did come mainly from cultivating an ever increasing share of the agricultural land base. Indeed, from 1964 to 1983, the annual average rate of cereal yield growth was negative in Mali, since then, however, increased cereal production has been sustained by a combination of increased yields and area cultivated.

The index of food insecurity for **Botswana** in 2009 is of 48,92, but despite being very close to the one of Mali, it represents an impressive worsening condition of food security in this country. At the beginning of the time period covered, Botswana ranked at the 45th position with a FIMI value of 47,50, most of the deterioration occurred between 1995 and 2000, years in which Botswana scale down of 17 positions.
Within the four dimensions of food security, stability has shown a sharp increase of all its indicators in 2000, especially in the cereal import dependency ratio that reached 99,08%. The agricultural sector's share of gross domestic product (GDP) has fallen significantly in Botswana, from 35 percent at independence in 1966 to only 2 percent by 2001. Despite this, however, half of the country's population lives in rural areas and depends on agriculture for food, income, and employment. In fact, in 2000,over 40 percent of the total labor force works in the agricultural sector. That is why the high levels of import dependency result from large volumes of commercial food imports.
Furthermore years of persistent drought occurrence and poor soil conditions have resulted into low crop yields (Whiteside 1997; ASTI 2004) and again in large food aid shipments to the region. A special note should be made on Botswana, which is often quoted a an example of a country which has managed successfully periods of food shortage, but the country's favorable foreign exchange situation, thanks to its gold production, has of course facilitated the needed commercial food imports.

A discontinuous trend is shown during the all period by **Malawi** that goes down from the 7th position of 1995 to the 17th position in 2000 and then scale up to the 11th position in 2005 to go back at the 22nd position in 2009. Those changes are driven by the stability dimension, particularly within the indicators related to food production index and cereal import dependency ratio for all the period covered by this study. Indicator of cereal stock variation shows a sharp increase from 2000 to 2005, while is the indicator on area harvested to increase most in the period 2005-2009.
Malawi experienced a serious harvest shortfall in 1992. Since 2002, food crises have been a recurrent, although not annual, phenomenon. The 2002 food crisis led nearly a third of the population depended on food aid. The causes of Malawi's recent food crises are several. It is noteworthy that the 'production shock' in 2002 w:

than during the 1991/2 drought. There was not simply a decline in agricultural production but also a decline in purchasing power. Macro-level decisions such as the sale of the strategic grain reserve also played a part. Both production and purchasing power were diminished due to AIDS, as people needed to spend time and resources on medicines and funerals, labor was lost, and the dependency ratio increased. The increasing prevalence of HIV/AIDS is contributing to increased food insecurity is becoming always more a concern (Malawi National Vulnerability Assessment Committee, 2003).

Since 1995 **Rwanda** has shown a strong change in the ranking moving from the 2nd position held in 1995 to the 17th in 2009. With no doubt the overall country situation between 1994 and 2000 has been dramatically affected by the genocide committed in 1994 and its consequences. The most remarkable improvement in food security was registered, not surprisly, in the period 2000-2005 mainly driven by the recovery from the internal conflict. The stability dimension value, in consequence, records sharp decreases in 2000 (with respect from 1995) going from 66,25 to 37,84 and again in 2005 (the value registered is 28,12). Within the stability sub-index, the indicator on the variability cereal harvested land capture how, parallel to the conflict recovery, the agricultural activities have restarted. The value of 57,22 is not consistent with the Rwandan landscape that usually poses a thorny problem of availability of arable land that, because of the high population density, is exploited to the very limits of agricultural possibilities and often beyond. It seems clear that the data registered for 2000 (therefore the variability is assessed over 1995) is biased by the genocide and the value registered in 2005 (8,26) and confirmed for 2009 is one of the principal component of the decrease of the overall index. It follows that also the indicators on Food Production Index and its variability have shown similar trends contributing to improve the availability of food in the country.

Tanzania in 2009 is at the 16th position of the ranking and compared to 1995 the country went back of 11 positions especially during 1995 – 2000 (- 9 positions). However both the overall index neither the sub-index show a big worsening in values, in fact FIMI in 1995 was of 52,60 and in 2009 of 53,81. Most of the change is more probably to attribute to the amelioration of the countries lying close to Tanzania in 1995, Lao PDR and Nicaragua in 1995 were, respectively, at the 26th and 25th position and at the 34th and 38th in 2009. Even if the dimensions of food security remain quite stable in all the period, Stability shows an increase in value among 1995-2000 in the indicators of "Cereal stock variation" and "Food Production Index". Those changes reflect the decision taken by the Government in 2000 to guarantee food security to the population after a season of bad weather conditions. In fact, according to the Rapid Vulnerability Assessment report, released by the government of Tanzania in 2000, the cereal (especially maize) The Ministry of Agriculture and Cooperatives used the Strategic Grain Reserve Stocks to mitigate the effects of extended drought caused by below-average and sporadic rainfall conditions with consequences of reduced harvests of food and cash crop (FEWSNET 2000).

It could surprises to find **Mongolia** at the twelve[th] position as this country is one of the least populated in the world with only around 1.7 people per square kilometer and therefore it should be able to feed its own population. However the FIMI indicates that between 2000 and 2005 the vulnerability to food insecurity, especially in the Availability dimension, increased a lot putting the country from the 26th position to the 14th. The 2005 worst wheat crop on record forced Mongolia to increase expensive imports further to ensure enough food was available resi

agricultural prices (the price of potato increased more than three times). It is necessary to add that the overall index take mainly into account the production of cereals while Mongolia is mainly a livestock based agriculture and therefore the contribution of this sector in ensuring food security could resulted a little bit underestimated.

Most of the countries in the top ten list of the ranking are the same in 2009 and in 1995 signaling a persistent and alarming situation of food insecurity. From the countries that reached those unlucky positions after 1995, Kenya and Burundi show a high degree of deterioration in food security conditions.

Kenya in 1995 had a FIMI of 54,72 holding the 18th position while in 2009 the country occupies the 8th position with a FIMI of 55,90. It must be recognized that most of the worsening occurred between 1995 and 2000 (the country lost 10 positions) but at the same time no positive changes were registered indicating that the country is not able to recover since now. Even with a relatively liberalized agricultural sector, Kenya's agricultural production and productivity remain inadequate and have not made any progress on the food security front. Yields have not improved and as a consequence, Kenya remains food insecure and is increasingly relying on emergency food supplies and commercial food imports for a significant portion of her domestic food requirements (W.Gitu, 2004). The Stability dimension captures this behavior as the indicators on "Import Dependency Ratio" and "Food Production Index" show constant increases, especially between 1995 and 2000 where they respectively shifted from 10,41% to 81,90% and from 11,72% to 25,83%.

With a FIMI of 56,51,**Burundi** ranks over the lowest in the international comparison of index scores, which largely results from 10 years of conflict from 1993 to 2003 (Burundi joined the first places in the ranking in 2000), in fact it has lose 23 positions from the beginning of the period under analysis. Fifteen years of civil war since 1993, combined with extreme poverty, a fragile political process and recurrent climatic shocks, have had a strongly negative impact on Burundi's economic and nutrition indicators (the indicator on the prevalence of undernourishment has jumped from 60,79% to an alarming 80,20%) impacting on both, Access and Utilization dimension. Also the Availability dimension shows a deteriorating situation and according to FAO, WFP and the UN High Commissioner for Refugees (UNHCR), experienced a per capita food production decrease of 24 percent since 1993 due to reduction in access to land and lack of production inputs and technical assistance. Apart from land, food availability in Burundi has been affected by market-related problems. A 2006 assessment by FAO, WFP and UNHCR cited poorly integrated markets due to high transaction costs, poor infrastructure and insecurity. Furthermore the country is one of the 'red zone' countries identified by both FAO and WFP as being most affected by soaring food prices and this is reflected on the high variability of the consumer price index registered in 2009 (46,28) with respect to the data of 1995 (8,61) that, in turn, involve a lowering in demand due to high prices and inflation, slow market turnover and decreased production and supply. After many years of conflict, the capacity of the government to respond to this new challenge seems to be limited.

Figure 7: FIMI MAP 2009

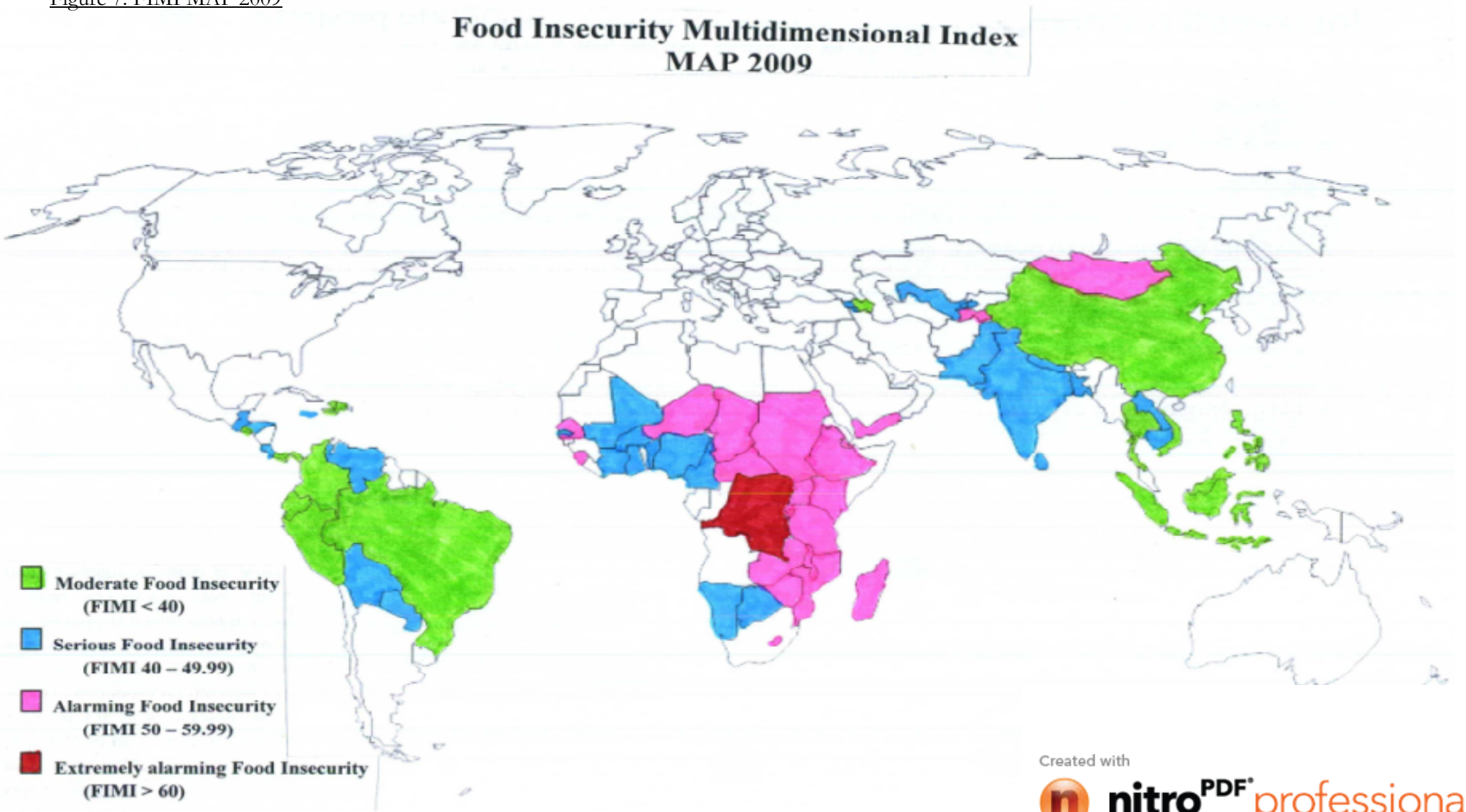
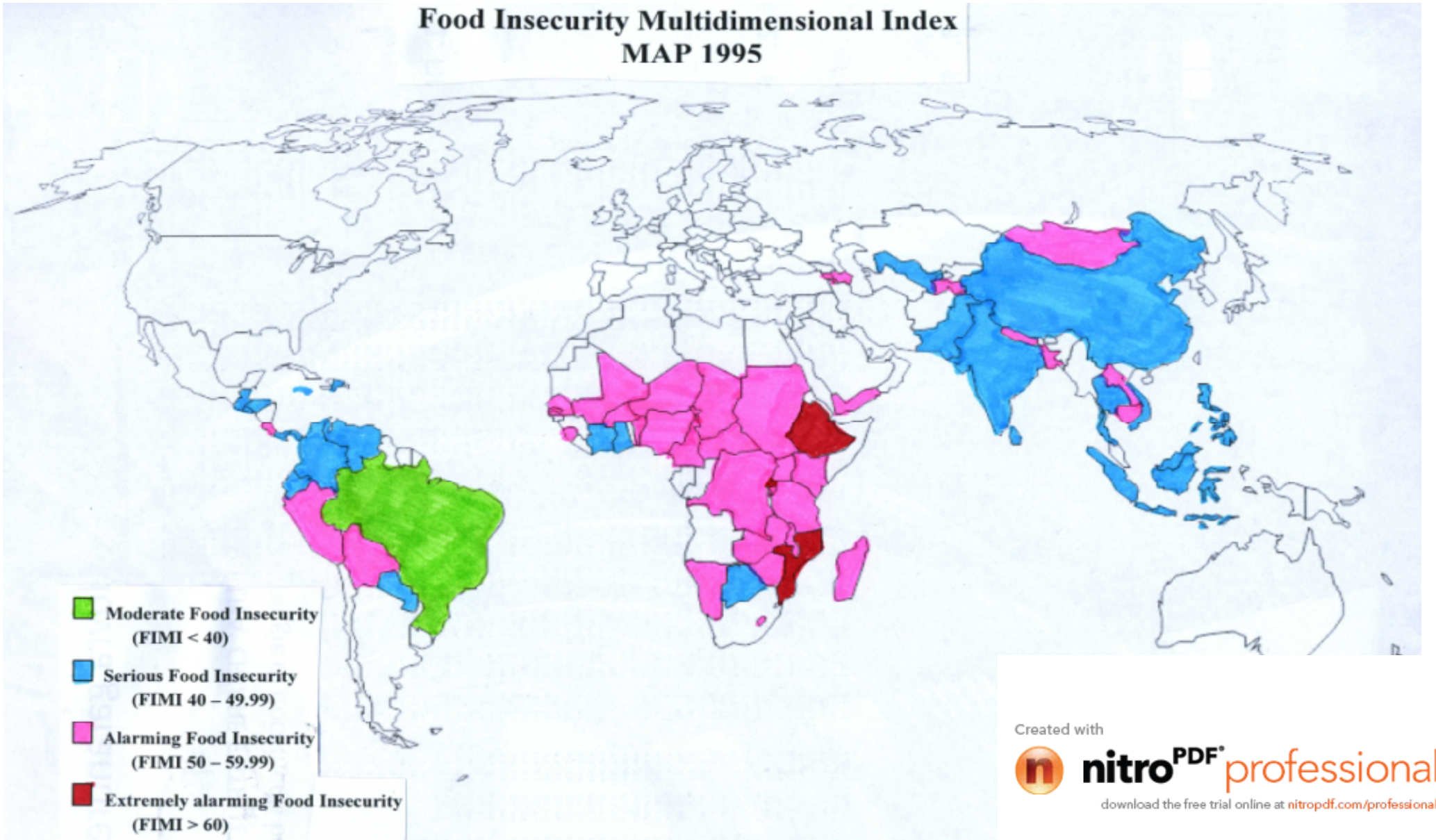


Figure 8: FIMI MAP 1995

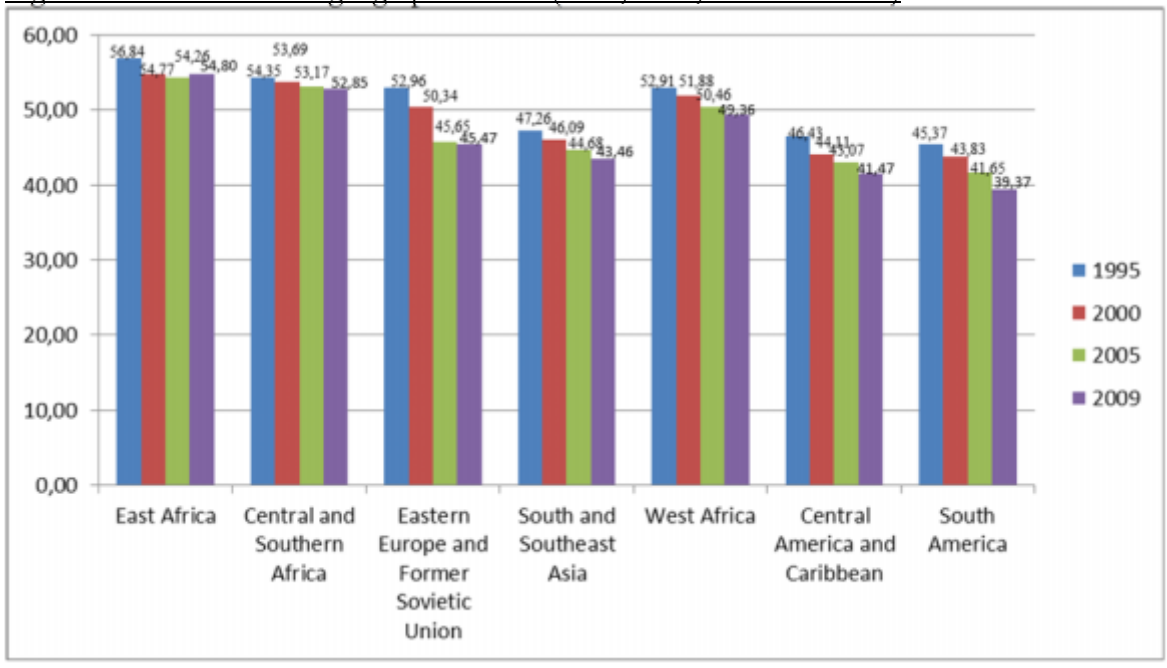


5.3 Regional Comparisons and Trends

Highly aggregated regional FIMI scores can easily conceal disparities within regions, the following overview for the regions is further differentiated in the next figures, where countries are grouped by regions and ranked by their FIMI and by their values for each dimension. Individual countries have been discussed in the previous paragraph, while the trends and patterns in regions will be here briefly described also taking into consideration the dimension of food security more involved within each geographical area.

All the regions show a trend of constant diminution of their FIMI value between 1990 and 2009 (figure 8). For Eastern Europe and Former Sovietic Union, in particular, the decrease has been around -14% and also the countries within Central America and Caribbean area have seen diminish their overall vulnerability towards food insecurity very positively (-10%), while the situation in Central and Southern Africa is quite unchanged in 20 years (less than -3%) denoting that the causes of food insecurity are intrinsically rooted in those countries.

Figure 8: FIMI trends for geographical area (1995, 2000, 2005 and 2009)

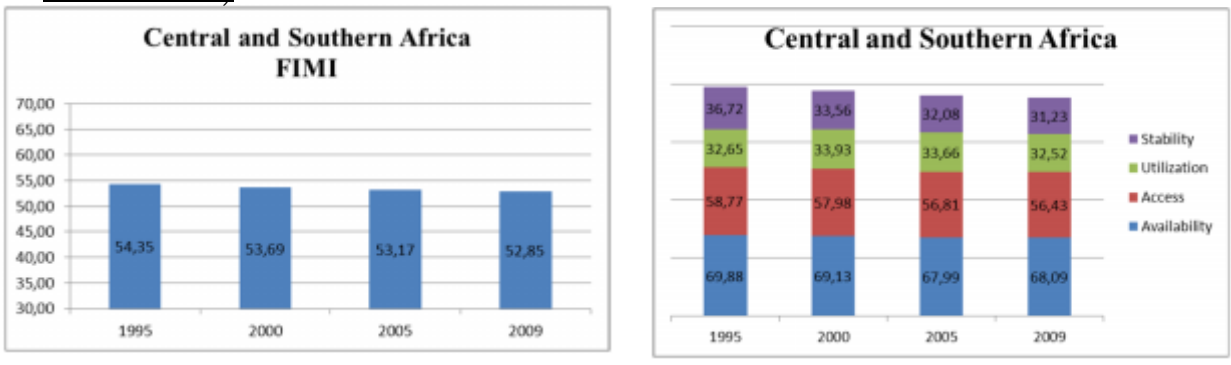


Among all the regions considered, the African registered the slower amelioration, but at the same time two different paces can be distinguished: for Central and Southern Africa and East Africa the trend, even if positive, is very low (not more than 4%) while countries of West Africa show a stronger change in their FIMI values over the considered years (-6%).

Overall progress from 1990 to 2010 was smallest in **Central and Southern Africa** (figure 9), despite the relatively high initial FIMI level of about 54,35 in 1990, its score increased by only 2.76 points in this period, indicating a modest reduction in food insecurity. The region counts seven countries studied of which in 1995 one was classified at a serious level of food insecurity (Botswana) and six at alarming level, the situation in 2009 shows impressive changes in positive and negative directions: Cameroon and Namibia moved from an alarming level to a s
positive trend) while in the Democratic Republic of Congo t

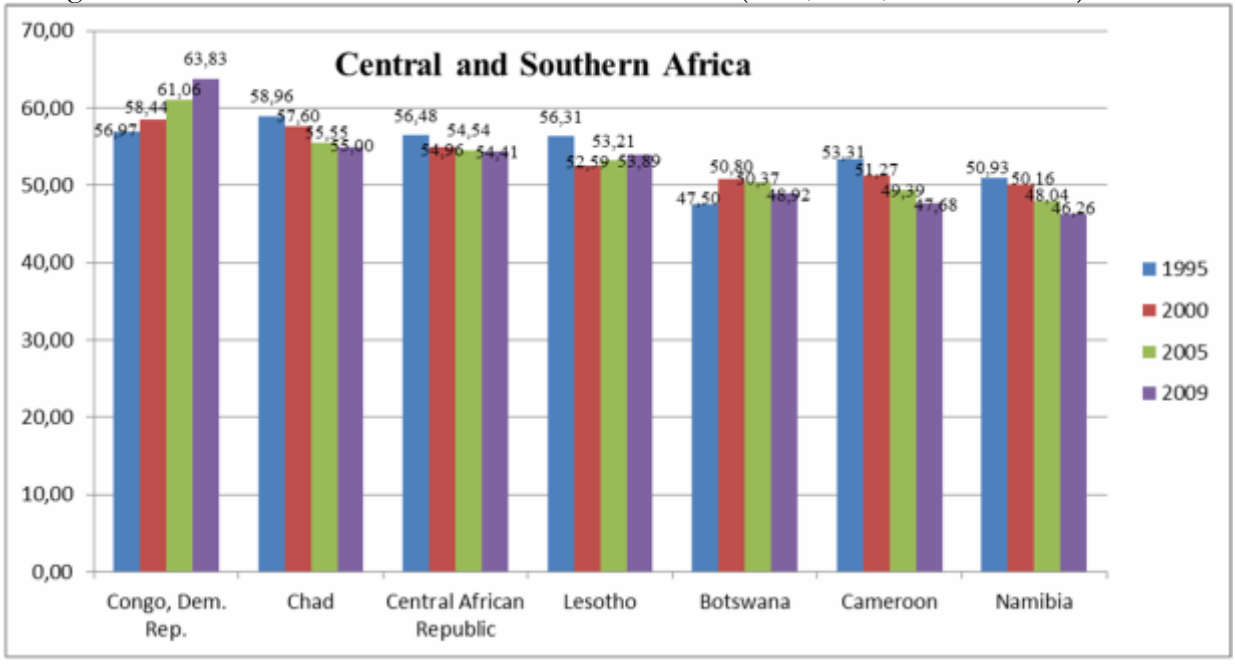
worsened from an already alarming situation to an extreme alarming level of food insecurity.
In Central and Southern Africa, declines in access and availability dimensions are not so relevant to indicate an improvement neither in the economic, social and physical assets of this area nor in the food production. Fortunately, the trend of the stability dimension has registered an impressive decrease by 17,58% showing that can raise hopes for a future improvement in the other dimensions.

Figure 9: Central and Southern Africa – FIMI and Dimensions values (1995, 2000, 2005 and 2009)



Large disparities are found within this region (figure 10): The FIMI for Cameroon dropped by 5,63 points from 1990 to 2009, while food insecurity soared in the Democratic Republic of Congo and its FIMI rose by about 6,06 points during the same period.

Figure 10: FIMI trends for Central and Southern Africa (1995, 2000, 2005 and 2009)



In **East Africa** the trend shown by the four dimensions of Food Security paints a complex situation where utilization and stability dropped impressively by respectively 28,15 and 17,41 points revealing an important amelioration of nutritional status (detected from the utilization dimension) even if the data registered for the access dimension seems to suggest that those results are not equally distribute

geographical area considered. Furthermore it must be considered that the overall progress is still quite low assessing itself at 54,80 in 2009 from 56,84 of 1995 improving only of 2,04 points and that the trend shown between 2000 and 2005 has increased proving that still this area has to face important challenges to achieve food security. From 12 countries belonging to this geographical area, in 1995, three were classified to be in a situation of extremely alarming food insecurity, they were Ethiopia, Mozambique and Rwanda, while the others 9 still presented an alarming situation. As previously said, in 2009 the overall situation of the Region has not changed so much as in all the countries the level of food insecurity is still alarming.

There is a large consensus among climatologists that temperatures in Eastern Africa are rapidly increasing and that climate change worsens the negative effects of La Niña events on rainfall declining per capita agricultural production have contributed to the current food crisis. Furthermore human pressure on natural resources is raising either because of a rapid population growth and of lack of means to adapt to the changing in climate.

Despite the decrease in the overall FIMI among 1990 and 2010 many countries of East Africa present a worsening situation in the reference time (figure 12) and it is possible to affirm that the positive trend of the region is driven especially by Malawi and Rwanda that have lost respectively 9,50 and 7,42 points. On the contrary, in the period considered, FIMI for Burundi increased of 4,09 points especially between 1990 and 1995 and between 2000 and 2005.

Figure 11: East Africa – FIMI and Dimensions values (1995, 2000, 2005 and 2009)

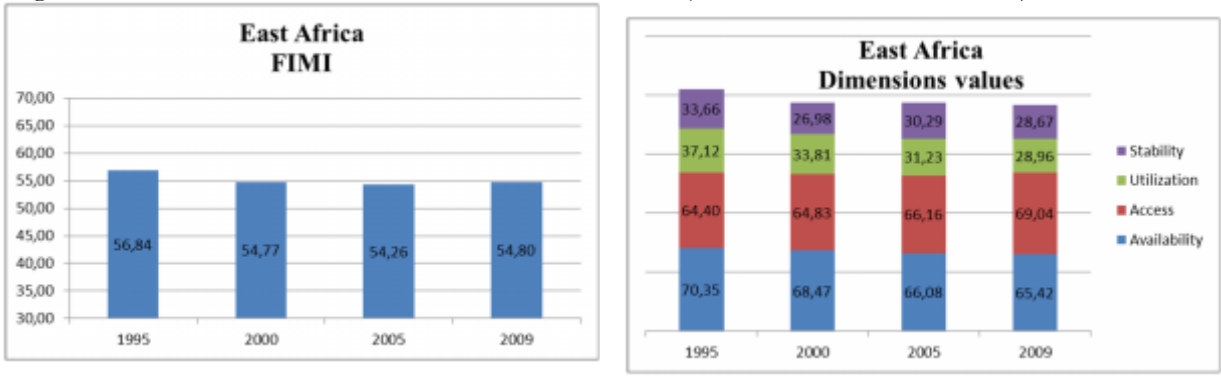
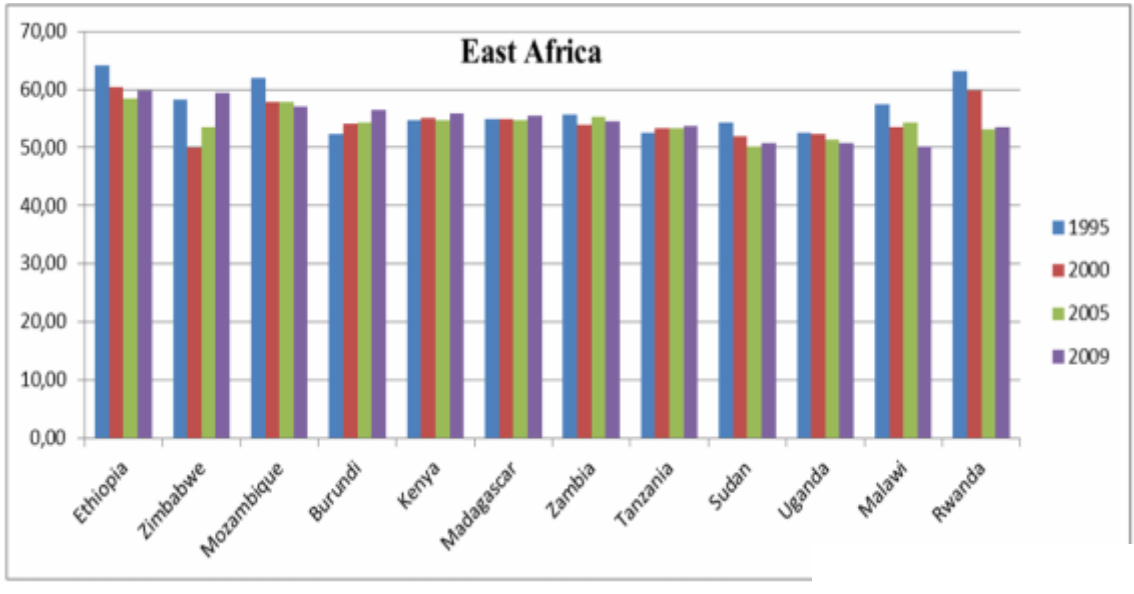


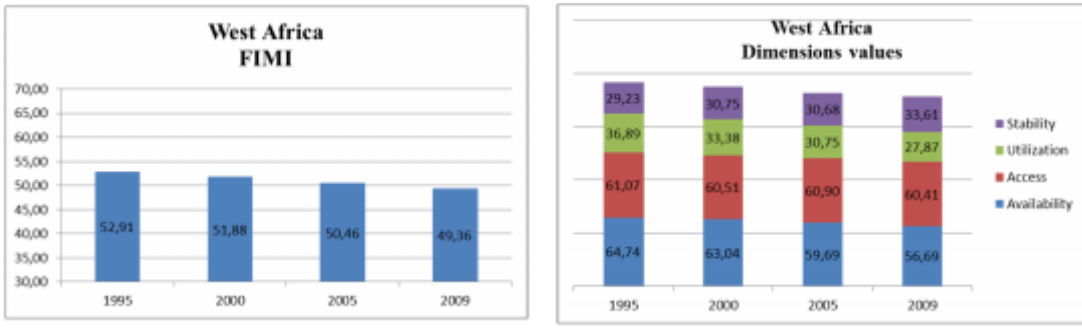
Figure 12: FIMI trends for East Africa (1995, 2000, 2005 and 2009)



The reasons behind food insecurity in Burundi are consistent with the overall scenario drawn for all the region: Food availability represents an important challenge as a FAO WFP regional report for 2010 affirms that the production of major crops has declined drastically over the last 15 years. This declines is attributable to many reasons among which: lack of appropriate improved seeds and or planting materials, Human pressure on the land, Repeated drought, flooding and huge mass wasting that have repeatedly been felt in Northern Burundi and part of the wet central plateau, Lack of credits facilities for farmers and the prevalent civil strife in Burundi for the last 17 Years (Mukhebi, 2009). Good examples are represented by Malawi and Rwanda above all given the prevailing levels of poverty they indicate less food insecurity than expected according to GNI per capita. The Regional Food Insecurity Update for Burundi (2010) states that the food security situation of the country remains favourable except for some households in four districts. In general, food is available for most households from own production or procurement from the market. • Small and medium size traders have adequate stocks of maize which is sold at various markets throughout the country.

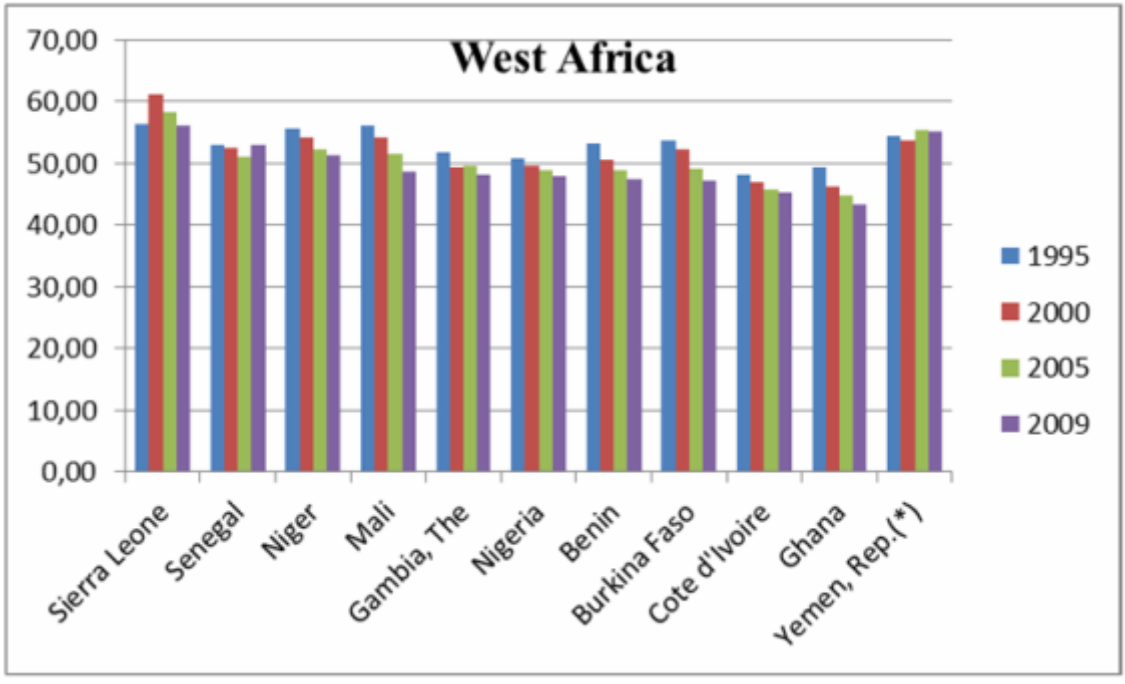
Within the African continent the **West Africa** shows a rose in food security conditions as signalized by the FIMI value that dropped from 52,91 in 1995 to 49,36 in 2009, furthermore another important difference with respect to the other geographical areas, is that the decrease in FIMI values is constant within the period (figure 13) despite not shared with the same degree by all countries (figure 14). In the reference time over ten countries, eight presented an alarming level of food insecurity and two a serious one, at the end of the series the situation were reversed as only three countries persisted in an alarming level of food insecurity, Niger, Senegal and Sierra Leone, while the other ones improved their levels.

Figure 13: West Africa – FIMI and Dimensions values (1995, 2000, 2005 and 2009)



Western Africa show higher levels and rising trends of food availability and utilization that, in fact, decreased, respectively, of 8,04 and 9,02 points from 1995 to 2009. Both economic growth and growth in agricultural incomes have been strong in Western Africa (particularly fast in Ghana and Nigeria)—where they also appear to be, for the most part, accelerating. The region has some notable improvers including Mali, Benin and Ghana, while in FIMI terms, Senegal is the weakest performer in Western Africa. For the best performers the agricultural sector has been a driving force in the last decades: the yields of the most important staple foods doubled , the area under cultivation expanded, and dietary energy supply per capita rose considerably as the data on the utilization dimension confirms both in absolute value and in country values (see table 24). Senegal is a case in point: its agricultural performance over the last fifteen years or more has been one of the most disappointing in West Africa and therefore the economic growth does not appear to be driven by the rural sector but nevertheless the reduction in utilization reported is remarkable.

Figure 14: FIMI trends for West Africa (1995, 2000, 2005 and 2009)



(*) Yemen republic should be classified in the Near Est and North Africa geographic area, but as it would have been alone, the author decided to put this country within the West Africa region.

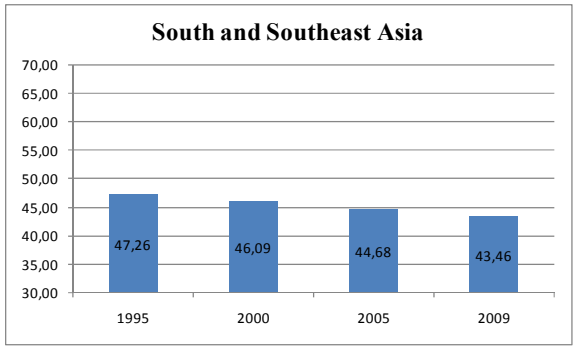
Finally, the picture for Western Africa appears mostly positive, but, however, one of the challenges to food security to deal with comes from the frequent instability and the slow growth in earnings or purchasing power of the people combined with the exposition to risks and threats of various order, intensity and frequency. Access dimension for West Africa has grown only of 0,67 points moving from 61,07 in 1995 to 60,41 in 2009 and Stability dimension dropped of 4,38 points registering 33,61 in 2009.

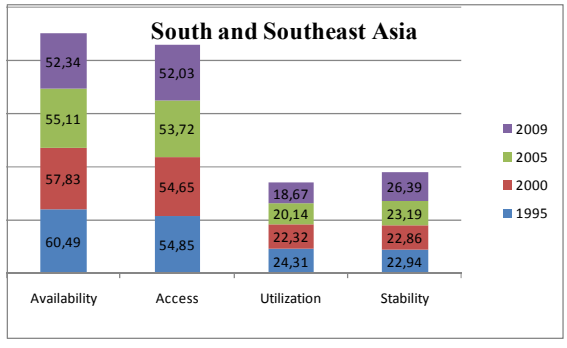
In contrast to the sluggish overall development in Africa, **South Asia** and **Southeast Asia** made great strides in combating food insecurity from 1990 to 2009. In 1995, the FIMI for South Asia indicated that the entire region was in alarmingly bad condition with regard to food security: the score was 47.23, five countries showed an alarming situation and eight a serious one. By 2003 South and Southeast Asia's regional score decreased of almost 4 points and notable reductions in food insecurity was registered among most of the countries in the region: only Mongolia remained at alarming level while five such as China, Indonesia, Philippines, Thailand and Vietnam shifted to moderate level (figure 15).

The twelve South and South Asian countries proposed in this study have several common features. They share a colonial past and are currently low or middle income level countries at different stages of economic development and therefore are characterized by rapid growth of population along with medium to high growth in their per capita income.
With only a few exceptions by the mid-eighties most of these countries succeeded in recording significant increases in their food production through the widespread adoption of new seed-fertilizer technology and none of these faced serious food shortages by the type experienced by them during the earlier period. This phenomenon has been punctually captured by the avai
decreased by 8 points since 1995 (figure 16).

Despite these successes, these countries face some formidable problems in the matter of providing adequate and stable food security to their people. First, these countries have succeeded in achieving only marginal self-sufficiency in food and some of them depend on fairly large imports. Second, in most of these countries, the present level of per capita availability of food grains is quite low also considering that most of those countries, like China, India and Pakistan have a considerable population. For most of the populous Asian countries, the most economic method of increasing per capita food availability is through significant increases in domestic food production. The third problem faced by these countries is that of wide year to year fluctuations in their agricultural and food grains production. Consequently, stability in providing food to their population still remains a formidable challenge as the related dimension shows: stability score increase by 3,45 points in the period. There are no doubts that the worsening of this dimension has been strongly affected by the recent food prices crisis that had different impacts across counties. For instance, in Vietnam a net reduction in poverty is expected when food prices rise due to the large share of the rural poor who are net sellers of food. However, in most countries, especially those with large urban populations, the poor are net buyers of food and are adversely affected by price spikes. Countries like Bangladesh and Cambodia are more exposed to higher import food prices.

Figure 15: South and Southeast Asia – FIMI and Dimensions values (1995, 2000, 2005 and 2009)

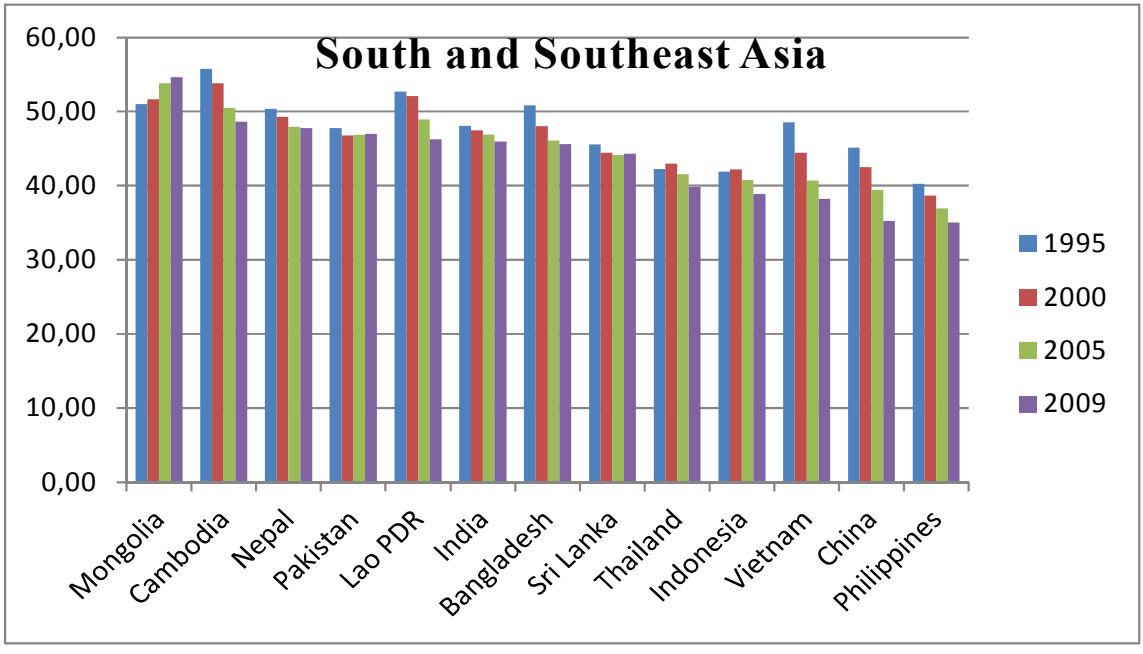




Within the region Mongolia represents a separate situation as it is the only country to experience a worsening in the FIMI index that shifted from 51,08 to 54,64 in 2009 (figure 16). With the availability dimension scores very high for both period (respectively at 66,90 and 67,93) the stability represents the second main driver as it dramatically increased by 20 points reaching the impressive score of 54,89. Both dimensions capture the overall situation in Mongolia, which in 1990 was economically unstable, in the transition between a planned economy and a market economy based on a process of general privatization. The series of bankruptcies which ensued spared no sector of the economy, making unemployment rise and product prices fall. Since 1999, the situation has not stopped deteriorating following successive climatic catastrophes: the «Dzüüds» in winter (very cold weather with strong snowstorms) and droughts in summer. This led to the death of more than 4 million animals (about 15% of the national herd), in a country principally made up of keepers of livestock. Such a crisis had a very heavy impact on food security of the poorest households. Finally in 2008, the global food crisis did strongly impact Mongolia. The cost of basic food items increased drastically: 160% for the bread and 140% for the rice.
It must be recognized that main livelihood source and the wealth in Mongolia is represented by livestock that are not deeply taken into account in the building of the

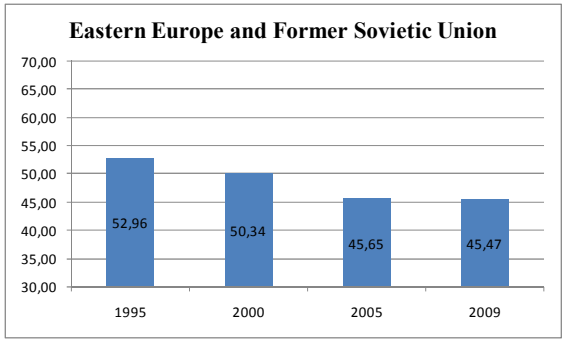
overall FIMI index and therefore the food insecurity situation for this country could be a little bit overestimate.

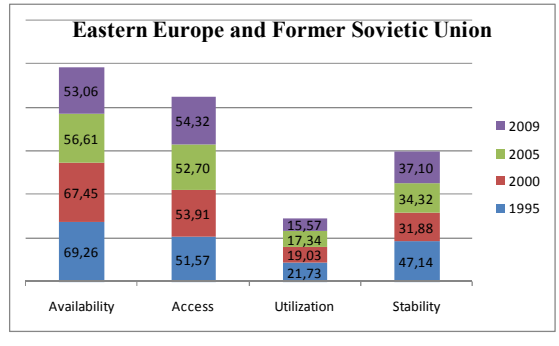
Figure 15: FIMI trends for South and Southeast Asia (1995, 2000, 2005 and 2009)



In Eastern Europe and Former Sovietic States, most of the countries came into existence after the dissolution of the Soviet Union or after the Balkan War in the 1990s and have experienced, under the period studied, a rehabilitation process well translated into the stability dimension that in fact has registered a good decrease from 47,14 in 1995 to 37,10 in 2009 (figure 16). The FIMI scores for the region register a net improvement in the food security aspect, in fact it declined by more than 7 points but as the figure 17 shows the pace has not been the same for all the countries within the region and 2 different situations can be found.

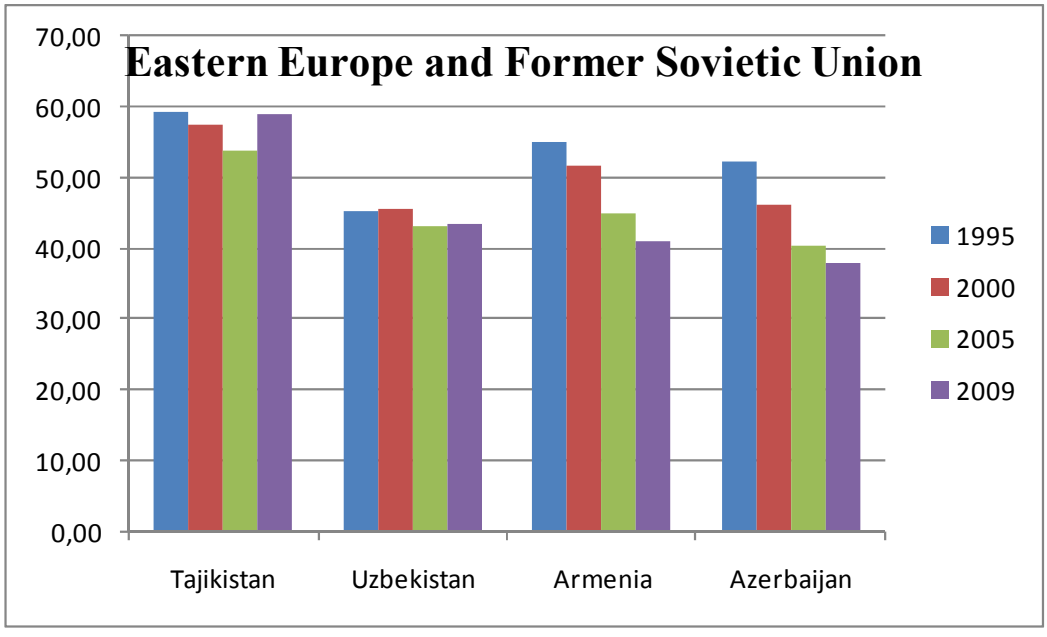
Figure 16: Eastern Europe and Former Sovietic Union – FIMI and Dimensions values (1995, 2000, 2005 and 2009)





Among the region the FIMI improvements are lowest for Tajikistan and Uzbekistan, in the period covered the index decreased by less than 1,5 points and highest for Armenia and Azerbaijan, they both improved for more than 10 points (figure 17).

Figure 17: FIMI trends for Eastern Europe and Former Sovietic Union (1995, 2000, 2005 and 2009)



This latter country, in particular, moved from an alarming situation of food insecurity to a moderate level making to register the better situation within the region. Following Azerbaijan example also Armenia succeeded in reducing iits vulnerability to food insecurity moving from an alarming status to a serious one. The little amelioration of Tajikistan (the dramatic rise in hunger in civil war-ridden Tajikistan between 1997 and 2003 stands out) and Uzbekistan did not allowed the countries to change their classification with respect to food insecurity, therefore they remained at, respectively, alarming and serious.

South and Central America and the Caribbean have shown a very similar trend in the period considered and therefore they will be discussed together (figure 18). Both regions had a diversified situation among countries in 1995: South America counted for 2 alarming countries (Bolivia and Perù), 4 showing a serious problem of food security and only Brazil registered a moderate vulnerability. The picture for Central America and Caribbean in the same period is quite similar in fact, if only one country (Nicaragua) had to manage an alarming food security situation, the other six countries within this region were considered facing serious problems. The communalities in trends between the two regions have continued all over the 20 years under exam and in both cases a general amelioration has been registered. In fact for South America the countries that in 2009 were classified as at moderate level of food insecurity rose to 4 (it is important to underline the impressive change for Peru that shifted from an alarming to a moderate situation) and to 3 for Central America while still 3 countries are facing a serious problem is satisfying the food needs of the population and 4 in Central America are in similar situation.

Figure 18: South America; Central America and Caribbean – FIMI and Dimensions values (1995, 2000, 2005 and 2009)

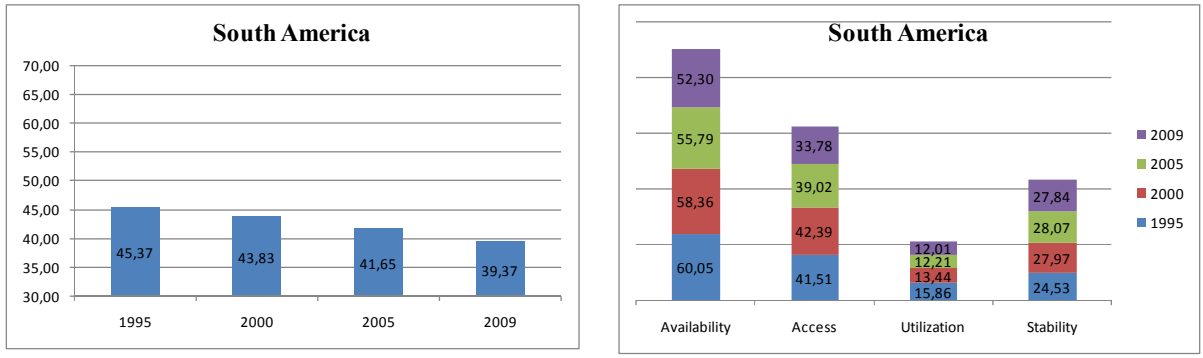
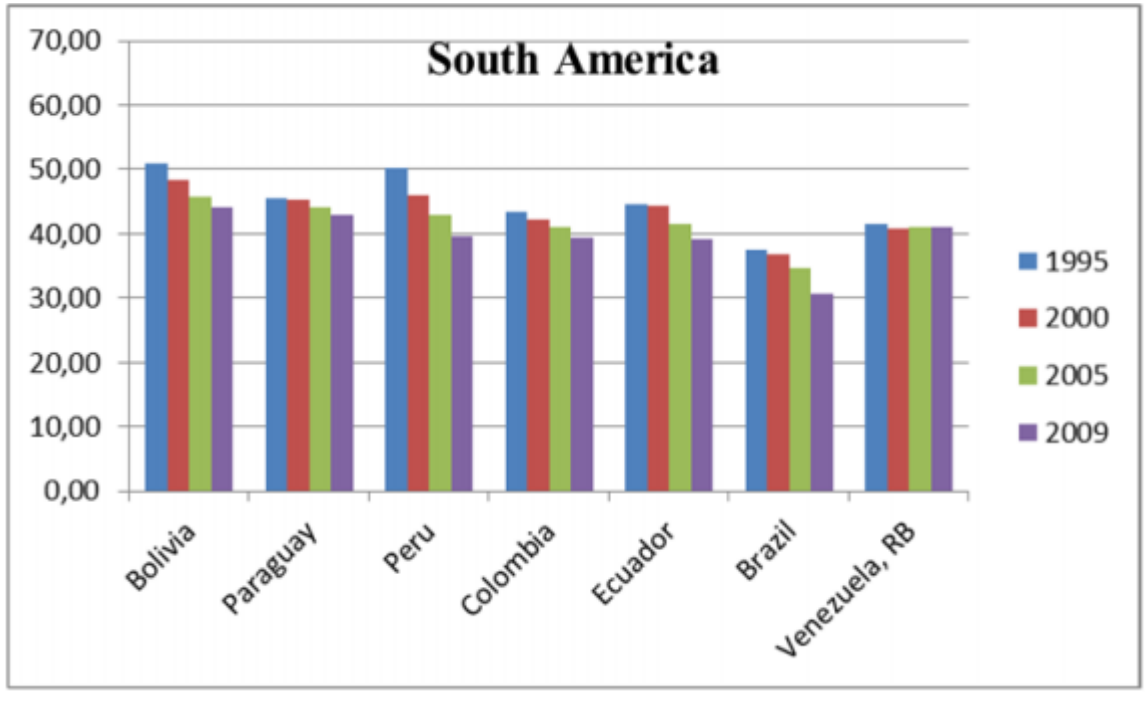
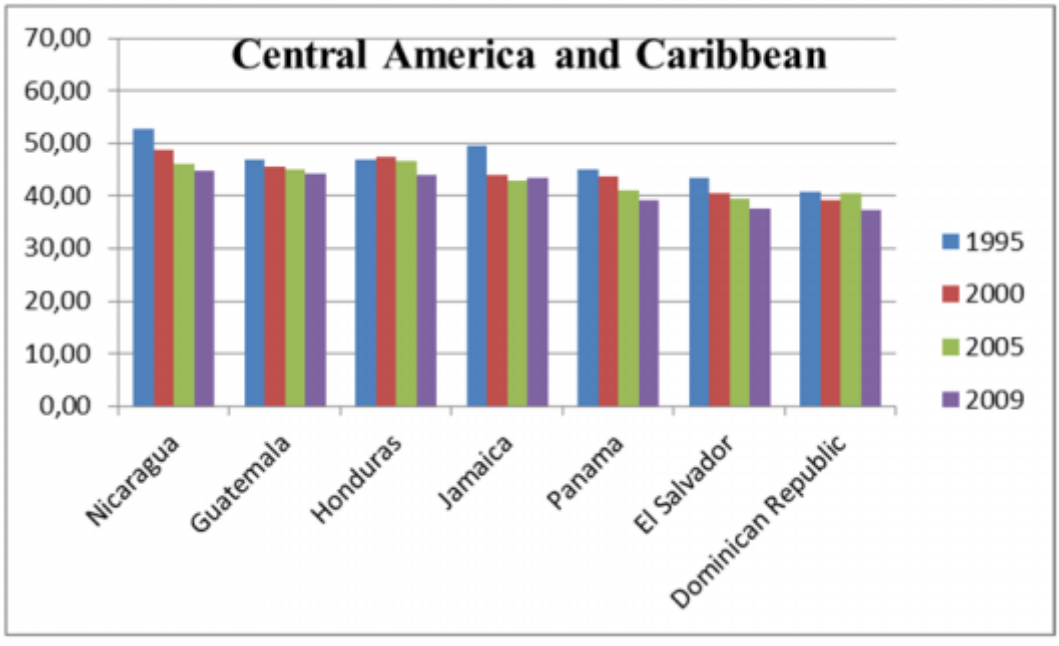


Figure 19: FIMI trends for South America; Central America and Caribbean (1995, 2000, 2005 and 2009)





From a dimensional point of view, utilization does not seem to be the first challenge for this region as well as stability that has strongly improved, especially in the Caribbean. The main challenges are represented by availability and access to food, nevertheless a study conducted by USAID in 2007 affirms that the region as a whole is steadily increasing per capita food supplies. All countries in the region are estimated to improve their food availability during the next decade. This increase in food supplies comes from rapidly growing food imports.

In the 20 years the state of food security has made important improvements all over the world. From the previous analysis it was recognized that over the 61 countries studied all have ameliorated their vulnerability towards food insecurity with exception of the Democratic Republic of Congo. This important success has to be attributed to the massive attention and efforts that have been deployed in the lasts decades in eliminating food insecurity and hunger.
Nevertheless, FAO in its "State of food insecurity, 2010" made an important warning that must make think about the efficiency of actions conduced since now and renovate the engagements, with an even greater effort, towards the eradication of food insecurity and hunger in the World.
"The number of undernourished people in the world remains unacceptably high at near the one billion mark despite an expected decline in 2010 for the first time since 1995. (…) However, a total of 925 million people are still estimated to be undernourished in 2010, representing almost 16 percent of the population of developing countries. The fact that nearly a billion people remain hungry even after the recent food and financial crises have largely passed indicates a deeper structural problem that gravely threatens the ability to achieve internationally agreed goals on hunger reduction: the first Millennium Development Goal (MDG) and the 1996 World Food Summit goal. It is also evident that economic growth, while essential, will not be sufficient in itself to eliminate hunger within an acceptable period of time."

6. CONCLUSIONS

The aim of this study was to set the basis for the development of a food insecurity composite indicator to assess countries' vulnerability to food insecurity across all of its four dimensions.

This Food Insecurity Multidimensional Index (FIMI) has been calculated for 1995, 2000, 2005 and 2009 for 61 countries, aggregating 20 indicators measuring availability (8 indicators), access (4), utilization (3) and stability (5).

The FIMI has been tested at country and regional level; countries' rankings in 2009 and eventual variations in rankings between 1995 and 2009 were then analysed, focusing on the impact of each dimensional sub-indexes on the overall one.

FIMI findings show that East Africa and Central/Southern Africa are the hot spots of food insecurity, while positive trends prevail in South-Southeast Asia and Latin America and Caribbean.

Availability and particularly access to food are the most critical issues at a global level, underlying that food production and distribution fail to meet the neediest. Nevertheless, in most of the cases, reductions of the vulnerability to food insecurity were driven by an increase in availability: this was the underpinning rationale of improvements in South American and Caribbean countries as well as in Eastern Europe and Former Soviet Union.

On the contrary, worse performances in the availability dimension are registered in Africa (particularly Central and Southern), where the lack of food represents the main challenge towards the achievement of food security.

Results confirm that availability and access dimensions do not always follow the same trend: the presence of food in a country does not ensure that all population can access it. For example, availability scores in Eastern and West Africa showed an increase while access scores were deteriorated, thus representing the principal component of food insecurity.

Dimensional scores reveal a deep relationship between availability, access and stability, as the latter plays a key role in capturing the impact of the factors that affect the presence and accessibility of food in a country, such as recurring and unpredictable natural disasters, political and economic environment, conflicts, etc.

Common trends in availability and utilization were also found, meaning that the presence of food in a country is fundamental to allow improvements in the nutritional status of its inhabitants. Availability had a positive impact on utilization even where in presence of a worsening in the access dimension, as observed in Eastern/West Africa and Eastern Europe and Former Soviet Union.

In light of this, policies and innovations oriented to increase the availability of food (such as the *Green Revolution*) certainly contributed to the improvement of the food security situation in developing countries, but a concomitant action is needed to ensure access to food is also guaranteed, being this the component that mostly affects countries' performances.

Results arisen from the analysis of the FIMI index found strong support from acknowledged literature, especially when interpreting significant c
This consistency shows that the direction undertaken in b

considered meaningful, thus representing an encouraging premise for further developments of the index and analysis of the causes of food insecurity in the world.

The main limit of the study was represented by the lack of data, which strongly affected the selection of the indicators; in fact, several indexes had to be discarded, their availability not being large enough to guarantee an appropriate geographical and temporal coverage. In particular, indicators of access and utilization (road paved, food consumption expenditure, logistics performance, people affected by natural disaster, poverty headcount ratio at US$2 a day, wholesale price index, prevalence of wasting, prevalence of stunting, etc.) are available but regrettably their time and geographical extension is quite limited. Therefore this study has highlighted the strong need of data collection and dissemination to allow assessing a more comprehensive index of food insecurity.

A possible further development of this study could be to apply the FIMI statistical framework to a specific geographical area to develop a complementary index focusing on the aspects of food insecurity for which indicators are not available on a global scale. East Africa could represent a good candidate for the analysis, being the region in which the FIMI scores highlighted a worse situation.

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