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The role of food schemes in tackling hunger in developing countries

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Abstract

The problem of hunger in developing countries is a challenging one. The various attempts that have been made to eradicate hunger have all shown unsatisfactory progress, as evidenced by the fact that millions of people in developing countries still struggle to meet their basic subsistence needs. So far, hunger solutions have mainly focused on providing food security at different levels but without considering a country's developmental level. This indicates a need to fill a gap in our research knowledge about the relationship between a country's developmental level and its level of hunger. Furthermore, there is a need to translate such knowledge into a new tool for developing hunger solution models.

This study therefore takes an initial step in this direction by suggesting a new approach for fighting hunger. This approach highlights the link between a country's developmental level and the level of hunger. It also helps to bring a better understanding of the relationship between a country's *food scheme model* and the level of hunger. Thus far, no similar attempts have been documented in the research literature.

To promote this idea/concept, this study defines two types of hunger policies (i.e., *hunger-management models* or *food scheme models*). We differentiate these policies based on the number of criteria employed in the *hunger-management model*, namely the "low use of criteria" and the "high use of criteria." This study uses the word "criteria" to refer to particular means for addressing the hunger issue, such as encouraging farming, providing school meals, supplying food aid, and so on. This research aims to examine the relationship between a selected *hunger-management model* and the level of hunger over time and verify if better-fitting *food schemes* can serve as a tool to achieve better solutions for the hunger problem in developing countries. To achieve this study's aims, repeated measures ANOVAs were performed to assess the effect of a country's *hunger-management model* on the GHI score and its four outcomes over time.[1] For the sample, data for 131 countries were gathered for four representative years—namely 1992, 2000, 2008, and 2016—with the choice of these representative years being constrained by data availability.

The main findings of this study are as follows: (1) Two different behaviors for fighting hunger were evident. Countries with an initially more problematic situation (i.e., less developed countries with higher GHI scores and values for its four component outcomes) tend to apply a low

[1] **Four outcomes**: proportion of undernourished people in population (%), prevalence of wasting in children under five years old (%), prevalence of stunting in children under five years old (%), and the under-five mortality rate (%).

number of hunger model criteria when addressing their hunger problems. In contrast, countries with an initially less problematic situation (i.e., more developed countries with lower GHI scores and values for its four component outcomes) choose broader programs with a higher number of hunger-model criteria when attempting to solve their hunger problems. (2) Developing countries applying a high number of criteria in their *hunger-management models* demonstrate better progress in reducing their levels of hunger than those applying a low number of criteria in their hunger-management models.

Based on findings from the data analysis, this study offers a new conceptual tool to reduce hunger in a more effective and controlled manner. It represents a hunger-fighting solution that is based on an original *hunger-fighting approach* that effectively combines existing solutions for countries at different levels of development. This new approach can be considered as the product of outside-the-box thinking that is currently under represented in the research literature. The suggested approach also supplies the various decision-makers with a dynamic working plan for generating more focused solutions that better fit the local and global socioeconomic changes over time.

This study therefore introduces a first-rate research tool for developing hunger solutions, but it also warrants additional investigative work: Firstly, the research should be expanded to include other regions and countries, because such an extended study could reinforce the findings of this study. Secondly, region-based hunger criteria could be developed for the unique natures of particular regions, and this could help to gain a better understanding of the link between a *hunger-management model* and the level of hunger, as well as improve countries' progress in reducing their level of hunger over time. Thirdly, the new concept could be adapted for developed countries, because it will be interesting to see whether this new concept could apply to the hunger problem in these countries, possibly by developing *hunger-management models* based on socioeconomic indicators. Such further studies could encourage the scientific community to recognize this new approach as a promising and unique concept for fighting hunger in both developing and developed countries.

Contents

Abbreviations

ASP - Agricultural Sector Policy
CAADP - Comprehensive African Agricultural Development Program
CCHIP - Community Childhood Hunger Identification Project
CM - Children Mortality
COAG - Committee on Agriculture
CPI - Corruption Perception Index
CPLP - Community of Portuguese Language Countries
CST - Children under the age of five suffering from stunting
CWA - Children under the age of five suffering from wasting
DHHS - Department of Health and Human Services
ENSAN - The National Strategy for Food and Nutrition Security
EWG - Environmental Working Group
FAC - Food Aid Convention
FAO - Food and Agriculture Organization
FFT - Food For Training
FFW - Food For Work
FNS - Food and Nutrition Security
FSP - Fertilizer Subsidy Program
GDP - Gross Domestic Product
GHI - Global Hunger Index
GIDD - Global Income Distribution Dynamics
GIZ - Gesellschaft für Internationale Zusammenarbeit
GM - Genetically Modified
GMF - Genetically Modified Food
GNI - Gross National Income
HDI - Human Development Index
HDR - Human Development Report
HIV - Human Immunodeficiency Virus
HP - Hunger Project
ICAR - Indian Council of Agricultural Research

IDB - Inter-American Development Bank
IFAD - International Fund for Agricultural Development
IFPRI - International Food Policy Research Institute
IHDI - Inequality-Adjusted Human Development Index
IMF - International Monetary Fund
INTERFAIS - International Food Aid Information System
IRDP - Integrated Rural Development Program
LSRO - Life Sciences Research Office
MDG - Millennium Development Goal
MDS - Ministry of Social Development
MPI - Multidimensional Poverty Index
NAFCO - National Food buffer stock Company
NFHS - National Family Health Survey
NGO - non-government organizations
NSAC - National Sustainable Agriculture Coalition
ODI - Overseas Development Institute
OECD - Organization for Economic Co-operation and Development
OHS - October Household Survey 1995
PAA - Food Acquisition Program
PNAE - The National School Meals Program
PPP - Purchasing-Power Parity
PROAGRO - Program to Promote Sustainable Agriculture
PRONAF - The National Program to Strengthen Family Farming
PUN - Population that is undernourished
REPOA - The Research on Poverty Alleviation
SARD - Sustainable Agriculture and Rural Development
SD - Standard Deviation
SPFS - Special Program for Food Security
SST - Sen-Shorrocks-Thon
UNDP - United Nations Development Program
UNICEF - United Nations International Children's Emergency Fund

UNSCN - United Nations System Standing Committee on Nutrition

USDA - U.S. Department of Agriculture

WCED - World Commission on Environment and Development

WEP - World Food Program

WFC - World Food Council

WFP - World Food Program

WFS - World Food Summit

WGI - Worldwide Governance Indicators

WHO - World Health Organization

WMR - World Malnutrition Rates

WTO - World Trade Organization

Thesis Glossary: Important New Terms Introduced in this Study

Food scheme model or hunger management model: This study introduces two new terms that are used concurrently in this study, namely *food scheme model* and *hunger-management model,* and this study uses these two terms interchangeably. A hunger-management model is based on two different hunger-fighting approaches: the low use of criteria and the high use of criteria in its model. By the term *criteria*, this study refers to the means used to address the hunger issue, and this could include activities such as encouraging farming, providing school meals, implementing food waste programs, supplying food aid, and so on.

One-dimensional hunger solution model: This is a hunger-solution model that focusses on one channel of activity in order to alleviate the hunger problem. For example, focusing on a single aspect, such as boosting agricultural food production, can be considered a one-dimensional hunger solution model.

Multi-dimensional hunger solution model: Such a model sees hunger as a complex, multi-dimensional problem, so it therefore requires a multi-pronged solution. It recognizes a need to work simultaneously on several channels of activities that are related to the hunger problem. This includes a combination of efforts like supporting family farmers, establishing school meal programs, facilitating food access, and so on.

Criteria: In using this word, in addition to its usual meaning, this study refers to the various means for addressing the hunger issue, such as encouraging farming, providing school meals, implementing food waste programs, supplying food aid, and so on.

The low and high use of hunger criteria: This relates to the number of criteria (see above) applied when fighting hunger, with four or more criteria being classed as "high use," while three or less was classed as "low use."

Hunger-management model (called also food-scheme, hunger model): A hunger-management model can be based on one of the two different hunger-fighting approaches presented above: the "low use of criteria" and the "high use of criteria" in the hunger-management model. In this study, developing countries that apply four or more criteria in their hunger-management models were classified into the "high use of criteria" group, while developing countries that apply three or less criteria in their hunger-management models were classified into the "low use of criteria" group.

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A PhD dissertation is a process, a long and fruitful journey, of finding insights of value and demonstrating your individual competence.

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Introduction

Why are there still so many hungry people in developing countries? Answering this question involves considering many aspects, not just from a moral point of view but also from a social and economic perspective. Different programs have been promoted by various agencies and organizations to address the hunger problem, yet hunger is still considered the main problem facing developing countries. This situation therefore raises two questions: (1) Could a dose-specific hunger solution more effectively address the problem in countries with differing levels of development? (2) Will a dose-specific hunger problem need a fresh approach and new insights to work more effectively?

These days, although the world has succeeded in reducing poverty in accordance with the MDG (Millennium Development Goals) targets, food security and adequate nutrition have not been fully achieved (H. Elver, 2015). Various hunger solutions have so far been developed and promoted to fight hunger in developing countries. Most of these policies offer hunger solutions that are mainly based on various research work undertaken by big organizations like the FAO. These studies have attempted to identify the underlying causes of hunger in developing countries, so they can be addressed. These studies have led to the formulation of various policies to fight hunger. For example, the FAO's study in 2011 pointed out that hunger is a food insecurity problem that principally results for three basic reasons: (a) low agricultural productivity, frequently caused by unsuitable policies and institutional and technological constraints; (b) seasonal influences on food supplies; and (c) a lack of off-farm employment opportunities in rural areas (FAO, 2011). The FAO's policies therefore focus on improving nations' food security through rapid increases in food production and productivity and enhancing people's access to food (E. E. Dooley, 2004). The FAO and WFP are well-known organizations that are deeply involved in fighting hunger in developing countries with leading food security programs like the Zero Hunger Program, the Twin Track Program, and the Special Program for Food Security (SPFS). Other organizations that have also adopted the food security concept include the NIFA (National Institute of Food and Agriculture), which addresses hunger and food security based on community food security (NIFA, 2017), and CIDA (Canadian International Development Agency), whose strategy is to achieve food security in developing countries by meeting basic needs, finding sustainable solutions, and encouraging innovation (CIDA, 2013).

Two important insights can be gleaned from the various hunger solution programs presented in the research literature: (i) The basic concepts behind these programs are very similar with some common working plans such as promoting agricultural and rural development, providing direct and immediate food aid to fight hunger, and providing agricultural training. What is more, (ii) the existing solutions so far use a basic approach mainly focuses on addressing the causes of hunger but without considering a country's developmental level.

Therefore, despite continuous efforts, hunger remains a major problem in developing countries, and so far, no significant success or real progress in eliminating hunger has been achieved. This indicates that eliminating hunger will require a pragmatic shift in how we address the hunger problem, as well as the development of a new model based on a different concept. This study takes up this challenge and introduces a new model to address the hunger problem in developing countries. To be more specific, this study proposes an original *hunger-management model* (i.e., *food scheme*)[2] that applies an effective combination of existing solutions for countries at different developmental levels. It is a new and unique hunger-management model that could be considered as being based on outside-the-box thinking that is thus far unrepresented in the research literature.

This research aims to fill a knowledge gap in the scientific community and enhance decision-makers' understanding of the relationship between a developing country's *hunger-management model* and its level of hunger. In addition, it seeks to translate this new knowledge into a unique tool for developing a hunger-management program.

While considering this study's suggested new solution to hunger, special attention should be paid to the following two concepts that are used concurrently in this study: *food schemes* and *hunger-management models*. This study uses these two terms interchangeably. In this study, a *hunger-management model* can involve two different hunger-fighting approaches: the low use of criteria and the high use of criteria in the hunger-fighting model. By criteria, this study refers to the various ways of addressing the hunger issue, such as encouraging farming, providing school meals, implementing food waste programs, supplying food aid, and so on. Accordingly, this study's sample of 131 developing countries was divided such that countries that applied three or less criteria in their *hunger-management models* were classified into the low-use-of-criteria group. These countries are also referred to in this study as "the more problematic countries." On the other

[2] The terms **hunger-management model** and **food scheme** will be explained later in this introduction.

hand, countries that applied four or more criteria in their *hunger-management models* were classified into the high-use-of-criteria group, and they are also referred to in this study as the "less problematic countries."

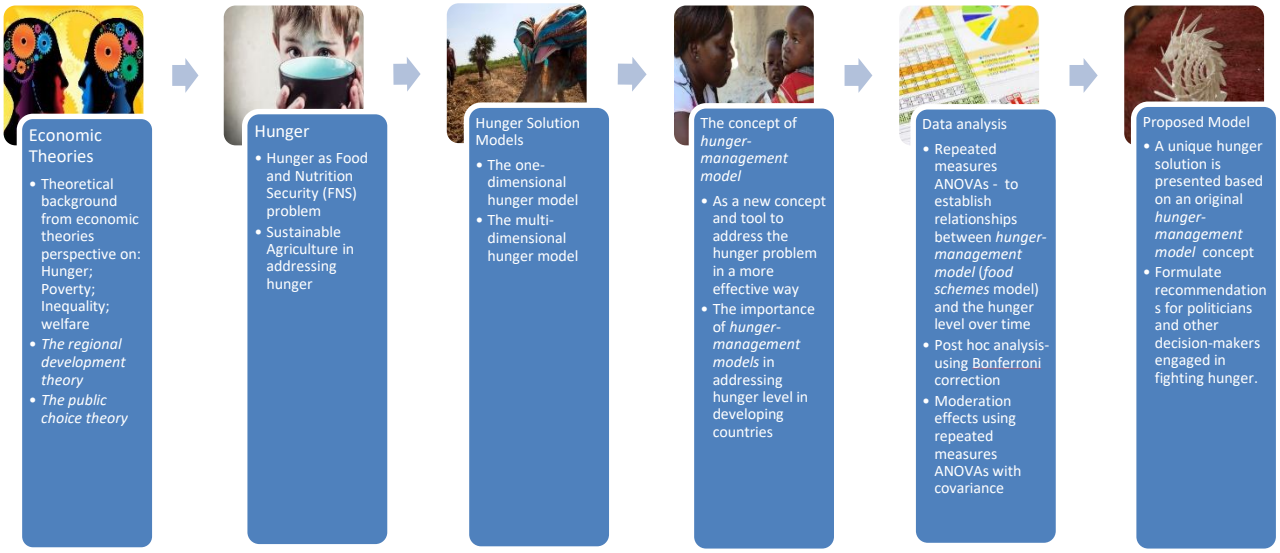
This study is based on three premises that are relevant to developing countries' progress in reducing their level of hunger over time: (i) The effectiveness of different solutions are reflected in positive progress in the GHI (Global Hunger Index) score over time. (ii) Any action to address the hunger problem delivers positive results at some level, as expressed by improved GHI scores over time. (iii) Countries' socioeconomic profiles show different socioeconomic performances, so differing levels of progress in GHI scores are achieved over time, even with identical hunger-management programs. These three assumptions emphasize the need to build hunger solutions that will fit countries at different levels of development, and they also indicate that eliminating hunger will need new insights. This study attempts to present such insights.

Thesis goal: This study's research set out to achieve following goal:

To develop a food scheme concept and verify if it can serve as a tool to develop better solutions for the hunger problem in developing countries.

Research hypothesis: There is a direct relationship between a hunger-management model and the level of hunger in developing countries.

The main points of interest for this study



This thesis is structured over five chapters to address its goal and prove or disprove its hypothesis:

Chapter 1 introduces the theoretical background for the concepts of *hunger*, *poverty*, *inequality*, and *welfare* with a focus on definitions and measurement, as well as considering them from the perspective of economic theories. This chapter also discusses two economic theories, namely *the regional development theory* and *the public choice theory*, which link between governmental institutions' decision-making and development. These can play an important role in reducing poverty and the level of hunger in developing countries. Moreover, this chapter presents three points of interest: (i) the paradigm of poverty and inequality in sustainable development; (ii) welfare economic theories for hunger, poverty, and inequality; and (iii) the concept of food and nutrition security (FNS) in terms of definition and theory.

Chapter 2 then moves on to discuss two points of interest: (i) hunger in the modern world, together with its local and global consequences, and (ii) the role of sustainable agriculture in addressing hunger.

Next, Chapter 3 introduces different hunger solution models and emphasizes the food security concept as a basis for leading hunger solution programs. Two basic solutions are introduced in this chapter. First, there is the one-dimensional hunger model, which conceives hunger as a food-deficiency issue whose solution is focused on one channel of activity, such as food subsidies, food aid, and sustainable agriculture. Second, there is the multi-dimensional hunger model, which conceives hunger as a failure to get food to those who need it, so the solution is focused on multiple channels of activities. Such programs include the Zero Hunger Program, the FAO's Twin Track Program, and the FAO's Special Program for Food Security (SPFS).

Chapter 4 then presents the concept of a *hunger-management model* from two areas of interest. First, it discusses it as a new tool and concept for addressing the hunger problem in developing countries in a more effective way. The new *hunger-management model* is based on two different hunger-fighting approaches: the low use of criteria and the high use of criteria in the hunger-management model. This represents a new way to develop a hunger solution program (i.e., food scheme) that comprises an effective combination of existing solutions for countries at different developmental levels. Second, this chapter eemphasizes the importance of the new *hunger-management model* for (i) promoting the idea of tailoring a hunger solution program to a

country's developmental level; (ii) tracking and analysing the achievements of different countries under different policies over time; and (iii) helping to gain new insights that may support future decision-making.

Chapter 5 then presents the data analysis and conclusions. The data analysis consists of three steps: Repeated measures ANOVAs were conducted for each GHI score and its outcomes.[3] The effect of change over time (main effect for time) was tested, as well as whether any change over time depends on the low or high use of criteria in hunger-fighting models. The possible moderating effects were also examined using repeated measures ANOVAs with covariance, while a post hoc analysis probed the differences between years using Bonferroni correction. Repeated measures ANOVA is the equivalent of the one-way ANOVA, but for related, not independent groups, and is the extension of the dependent t-test. A repeated measures ANOVA is also referred to as a within-subjects ANOVA or ANOVA for correlated samples. This test has three effects:

- Main effect of time (within subject effect) - a significant change over time in a respective hunger outcome in total.
- Main effect of group (between subject effect) - a general significant difference between two groups: countries that use low level of hunger model implementation vs. countries that use high level of hunger model implementation.
- Interaction effect – whether change over time *depends* on the hunger management model, meaning, is there a trend of change over time that differs between two types of countries. Having interaction effect emphasize the difference in hunger indices over time.

To probe differences between years, post hoc analysis was conducted using Bonferroni correction.

The conclusions section then presents some important insights into the relationship between the hunger-management model and the level of hunger. This includes noting that (i) countries with an initially more problematic situation (i.e., higher values in the five indicators) applied the low use of criteria in their hunger models, with the opposite being true for countries with less problematic situations, and (ii) both tracks show positive effects over time in terms of a significant decrease over time for each examined indicator. Based on these two insights, this chapter proposes a new hunger-management concept and working plan for countries trying to reduce their hunger levels. In addition, this chapter presents two economic theories that are both relevant, namely *the*

[3] **GHI outcomes**: the proportion of undernourished people in the population (%); the prevalence of wasting in children under five (%); the prevalence of stunting in children under five (%); the under-five mortality rate (%)

theory of regional development and the *public choice theory*, and these support this study's proposed solution to the hunger problem in developing countries.

The following materials and methods are used: To establish a statistical relationship between a hunger-management model and the level of hunger over time, this study defines two types of hunger-management model, which were used as the independent variable. These are "the low use of criteria in the hunger model" and "the high use of criteria in the hunger model." Each of these hunger-fighting approaches reflects a country's development level. Repeated measures ANOVAs were performed to assess the effect of a country's *hunger-management model* on the GHI score and its four outcomes over time. For the sample, data for 131 countries were gathered for four representative years, namely 1992, 2000, 2008, 2016, with the choice of these representative years being constrained by data availability. It was also regarded as important to confirm whether any additional variables had a moderating effect on the relationship between the two variables being examined (i.e., hunger-management models and outcomes). Possible moderating effects were therefore examined using repeated measures ANOVAs with covariance. The Corruption Index, the Human Development Index, Government Effectiveness, and Political Stability were examined as potential moderators.

The findings support this study's hypothesis about a direct relationship between the *hunger-management model* and the level of hunger in developing countries. Developing countries applying the high use of criteria in their hunger-management models demonstrate better progress in reducing their levels of hunger when compared to those applying the low use of criteria in their hunger models. Examining the moderating effect of each of the four potential moderators, meanwhile,[4] on the relationship between hunger-management models and specific outcomes did not reveal any significant interactions.

This study presents a unique hunger solution based upon an original *hunger-management concept* that combines existing solutions for countries at different developmental levels. It also suggests a new working plan for making decisions when formulating an effective and well-fitting program for countries at different levels of development. Such a working plan has three characteristics. First, it maximizes the positive effect over time on the general hunger score, as well as its component indicators. Second, it results in a dynamic program that develops over time in

[4] **Moderators:** The Corruption Index, the Human Development Index, Government–Effectiveness, and Political Stability

accordance with a country's progress in the various indicators, thus fighting hunger in a more focused way. Third, it represents an effective and controlled way to fight hunger using outside-the-box thinking that is so far absent in the research literature.

Further research is also suggested to focus on the following three topics: extending the research to other regions and countries, considering region-based hunger criteria, and adapting the new concept to the situation of developed countries.

Extending the research to other regions and countries: Such an extended study could reinforce the findings of this research, and this could encourage the scientific community to recognize this unique approach as a promising concept in the fight against hunger in developing countries.

Considering region-based hunger criteria: Developing hunger-management models for regions with their own particular natures could help to gain a better understanding of the link between a hunger-management model and the level of hunger, as well as improve the progress of countries in such regions in reducing their level of hunger.

Adapting the new concept to the situation of developed countries: An intriguing consideration for the new food scheme concept introduced in this study is whether it could be applied to the problem of hunger in developed countries. In developed countries, the hunger problem has its own nature. It is a socioeconomic government policy problem that is linked to poverty, unemployment, and other social factors (I. Nyambayo, 2015). In other words, the *hunger-management models* of developed countries could be based on socioeconomic indicators.

This research makes a substantial contribution to the existing knowledge and proposes a practical new tool to support decision-makers engaged in the fight against hunger in developing countries. The new *hunger-management model* concept presented in this study has several advantages over the existing approaches in the research literature:

(i) It has a direct link between the applied hunger-management program and the hunger level over time.

(ii) It provides a tool for tracking and analyzing progress in GHI scores under different hunger model criteria.

(iii) It allows the tailoring of a hunger solution to a country's particular level of development.

(iv) It helps to gain new insights that may support future decision-making in the fight against hunger in developing countries.

Chapter 1. Economic perspectives and theories regarding inequality, poverty, and hunger

1.1 The problems of poverty and inequality in historical economic thinking

1.1.1 Poverty as a central issue in economic theories

When thinking about hunger, it is impossible to avoid considering poverty and inequality. Poverty as a leading concept is inextricably bound with inequality and hunger, and it seems to be a central issue.

F. Naschold (2002) and A. Weisfeld (2008) conceive hunger as a symptom of poverty, because poverty leads to hunger. What is more, addressing inequality is key to reducing poverty. F. Naschold (2002) argues that inequality and poverty influence each other, both directly and indirectly, through their links with economic growth. For example, poverty can be reduced by increasing overall incomes, distributing wealth better, or some combination of the two. The international organization The Hunger Project also considers hunger to be a symptom of poverty and inequality, and they have found it can be viewed as a dimension of extreme poverty (A. Weisfeld, 2008). For E. Seery et al. (2014), hunger, like poverty and inequality, is a negative aspect of the human social condition and a key factor in economic configurations where financial resources are unequally distributed (E. Seery et al., 2014).

The economic schools of thought present diverse values, which primarily result from varying paradigms and worldviews. Each economic approach has an important contribution to make when understanding poverty and the related concepts of hunger and inequality. This subsection provides an overview of the definitions for poverty and the main economic theories that relate to the causes of poverty, as well as reflecting on our understanding of inequality and hunger.

In the literature, two radically different views of poverty exist. Early on, the notion that poor people had no potential to be anything other than poor, so poverty would inevitably persist, was challenged. Jean-Jacques Rousseau (1712-1778) proposed such a way of thinking when he claimed that poverty was avoidable. In fact, antipoverty policies in both Western and Eastern thinking have existed for more than 2,000 years. While social protection was well understood among the elite classes, mass poverty was largely taken as given. There were therefore few efforts

to permanently reduce poverty, and the promotion of antipoverty policies made little sense to those in power (M. Ravallion, 2016).

Poverty on a global scale came to be regarded as a problem following World War 2. Prior to 1940, it simply was not considered an issue. On the rare occasions that "poverty" was mentioned in documents during the 1940s and 1950s, it took the form of statistical measurements of per-capita incomes that were far below the US standard. While the scale of income was believed to indicate social status, the perception of poverty on a global scale was limited to the result of a comparative statistical operation. Economist Cohn Clark carried out the first such study in 1940. As soon as a scale of incomes had been established, different worlds could be classed together.[5] However, at the same time, a comparison with the richest nations showed them in a position of almost immeasurable inferiority. This conceptualization provided justification for intervention when the problem was low income, with economic development and growth being the only way to banish it. In this way, economics took up an important role in the concept of poverty over time (I. Rodrlguez, 1992).

The proposed responses to poverty by the different schools of economic thought are greatly influenced by the definition of poverty that each school employs. Leading definitions for poverty over time can be divided into two main groups: historic definitions and contemporary definitions.

In the historical context, Adam Smith defined poverty as "the inability to purchase necessities required by nature or custom." He therefore believed that poverty involved much more than just physical deprivation. In this definition, the social/psychological aspect of poverty implicitly carries the same weight as the material, purely economic condition. He also clarified the sort of necessities that are needed to be considered not poor (A. Smith, 1776, p.3). In 1847, Karl Marx (cited in J. C. Wood, 1988) was more explicit about the specific and relative dimensions of the notion of poverty. He defines poverty as follows: "Our needs and enjoyments spring from society; we measure them, therefore by society and not by the objects of their satisfaction. Because they are of a social nature, they are of a relative nature." J. Rowntree (quoted in P. Townsend, 1979; H. Glennerster, 2004) proposed a different concept of poverty in the early 20th century. He distinguished between primary and secondary poverty, where primary poverty is "earnings insufficient to obtain the minimum necessary for the maintenance of merely physical efficiency,"

[5] **Different worlds** could include, for example, the Zapotec people of Mexico, the Rajasthanis people of India, and the Tuareg people of North Africa.

while secondary poverty referred to those living below the poverty line, despite having a sufficient income, because they spend money on things other than the necessities of life.[6]

In contrast, contemporary economists supply definitions for poverty that present quite different aspects. Amartya Sen is one of the most important contributors in the development of poverty literature. For Sen, the socioeconomic environment surrounding the individual gives this notion of poverty a sense of relativity. In Sen's own words, "poverty is an absolute notion in the space of capabilities but very often it will take a relative form in the space of commodities or characteristics" (A. Sen, 1983). Poverty is the result of insufficient entitlements. These are defined as a broad package of rights including health, education, and freedom, and they are "indicators of freedom to live a valued life" and realize human potential (A. Sen, 1999). P. Townsend (1979) defines poverty as "the lack of the resources necessary to permit participation in the activities, customs and diets commonly approved by society," which is a purely relative measure. According to this author, the flow of resources toward individuals is governed by a set of different systems operating for each of them. Poverty is in part the outcome of the combination of these systems at work, with some, such as wage and social security systems, affecting a greater portion of the population than others.

Other definitions of poverty have been put forward by different *organizations*. The World Bank (cited in M. Ravallion, 2008) states that "a common method used to measure poverty is based on incomes or consumption levels. A person is considered poor if his consumption or income level falls below some minimum level necessary to meet basic needs." This minimum level is usually referred to as the "poverty line." The World Bank uses a reference value of $1.9 per day (in terms of 2015-based purchasing-power parity). Such simple monetary approaches to measuring poverty are widely employed in areas such as tracking progress towards the Millennium Development Goals. Nevertheless, the World Bank (2004) also offers a more detailed definition of poverty that can be adapted to different country conditions: "A pronounced deprivation in well-being, and comprises many dimensions. It includes low incomes and the inability to acquire the basic goods and services necessary for survival with dignity. Poverty also encompasses low levels of health and education, poor access to clean water and sanitation, inadequate physical security, lack of

[6] **The poverty line** is "the minimum level of income deemed adequate in a particular country." In 2008, the World Bank revised its international poverty line to $1.9/day at 2015-based purchasing power parity (World Bank, 2015) http://www.worldbank.org/en/topic/poverty/brief/global-poverty-line-faq

voice, and insufficient capacity and opportunity to better one's life" (World Bank, 2000; N. Kotwani et al., 2012).

One of the broadest contemporary views of poverty comes from the European Union, which claims that "people are said to be living in poverty if their income and resources are so inadequate as to preclude them from having a standard of living considered acceptable in the society in which they live. Because of their poverty, they may experience multiple disadvantages through unemployment, low income, poor housing, inadequate health care and barriers to lifelong learning, culture, sport and recreation" (European Union, 2004).

A definition of poverty that attempts to encompass the contexts of both developing and developed countries was published in the Copenhagen Declaration of the United Nations in 1995. During the summit leading up to the declaration, it was agreed that poverty includes a "lack of income and productive resources to ensure sustainable livelihoods, hunger and malnutrition, ill health, limited or lack of access to education and other basic services, increased morbidity and mortality from illness, homelessness and inadequate housing, unsafe environments and social discrimination and exclusion. It is also characterized by lack of participation in decision making and in civil, social and cultural life" (Copenhagen Declaration, 1995).

1.1.2 Economic theories of poverty in major economic schools

Various views of poverty are presented in different economic schools of thought, each making an important contribution to our understanding of poverty. This subsection analyses three major economic theories of poverty: *the classical and neoclassical schools* (the so-called "orthodox" approaches that initiated in the formal analysis of poverty in the 19th century); the theories that derived and departed from the foundational premises of classical economics by introducing a number of novelties (such as the *Keynesian/neoliberal schools*); and those that examine the problem of poverty from a completely removed perception of the socioeconomic system (namely radical economic theories like the *Marxist/radical schools*).

Classical economics developed mostly during the 18th and 19th centuries. This includes theories on both value and distribution and assumes that the outcomes of the exchanges taking place in the marketplace are efficient, so wages faithfully reflect individual productivity. This concept therefore views individuals as responsible for their own destiny, so the poor choose to be poor. In this view, poverty would therefore seem to be a consequence of poor individual choices,

such as forming a lone-parent family, because these so-called "wrong" choices of individuals could lead them into a "poverty or welfare trap." Several different approaches can be distinguished within the classical tradition, each emphasizing different factors as causes for poverty. According to this understanding, poverty is not a result of market failure but rather one of shortcomings in a person's own efforts and capabilities (P. Townsend, 1979).

Neoclassical theory stresses the role of unequal initial endowments of talents, skills, and capital, which together determine the productivity of an individual and can lead to poverty within a competitive economic system. Market failures (e.g., externalities) also negatively affect poverty (E.P. Davis, 2007). In addition, uncertainty may play an important role in the causes of poverty, because the well-being of the poor is more vulnerable to shocks. Neoclassical theories are more wide ranging, and they recognize that the reasons for poverty stretch beyond the control of an individual. These include a lack of social and private assets, market failures that exclude the poor from credit markets, barriers to education, poor health, and obstacles to employment for lone-parent families (E. P. Davis, 2014).

Looking at the classical and neoclassical approaches together, their main advantages are the use of quantified monetary units to measure poverty and the readiness with which policy prescriptions can be put into practice. These two approaches also highlight the influence of incentives on individual behavior, as well as the relationship between productivity and income. One criticism of these approaches is their overemphasis on the individual, such as by not considering links with the community and instead focusing on purely material means to eradicate poverty (E. P. Davis, 2014).

Keynesian/neoliberal theories revolve around the idea that it is not just market distortions that cause poverty but also broad underdevelopment in its multiple facets. Keynesians suggest growth can promote economic development and therefore relieve poverty, so it justifies government intervention at the macroeconomic level through fiscal and monetary policies aimed mainly at tackling involuntary unemployment (E. P. Davis, 2014). In the Keynesian/neoliberal perspective, poverty is mainly explained as "the misfortune of certain minorities who fall out of work, cannot work or are not expected to," although they may wish to do so. The state therefore needs to "regulate, supplement and exhort, but not impose" (P. Townsend, 1979). The theory contends that poverty can be a reflection of market failures, and under certain circumstances, it justifies redistributive taxation (E. P. Davis, 2014; S. Y. Jung et al., 2007). The neoliberal school

led by New Keynesian economics also adopts a money-centered, individual stance towards poverty. The importance assigned to the functions of government allows for a greater focus on public good and inequality. On the other hand, New Keynesian and neoclassical economists share the belief that overall growth in income is ultimately the most effective tool in combating poverty. However, unlike in the classical approach, unemployment is viewed as a major cause of poverty. It is largely seen as involuntary, so intervention is needed from the government. High inflation and sovereign debt, as well as asset bubbles, are other macroeconomic factors that are also believed to cause poverty (E. P. Davis, 2014).

The **Marxists** contend that capitalism, as well as the related social and political factors based on class division, is the cause of poverty. According to this school of thought, "The market is inherently dysfunctional and creates poverty" (Blank, 2010). It views capitalist societies as keeping the cost of labor unnaturally low through the threat of unemployment. The Marxist theory claims that capitalism creates a "reserve army of the unemployed," thus assuring the holders of capital access to low-cost labor. It therefore follows that poverty in a capitalist economy can only be alleviated through strict regulation of the market, such as through minimum wage levels. The political economy field, meanwhile, suggests that poverty results mainly from structural factors, including stratified labor markets, prejudice, and corruption. In all cases, the prevailing message is that anti-discrimination laws and labor market reforms are essential to overcoming the structural barriers that bring unemployment and cause poverty (E. P. Davis, 2014; R. M. Blank, 2003). By suggesting radical changes in the socioeconomic system, the Marxian view highlights the possibility that economic growth alone may be insufficient to lift poorer people out of relative poverty. Its advocates argue that many who belong to certain classes may not reap any benefit from overall income growth. A further contribution from Marxian/radical economists is the notion that poverty is a moral as well as a technical issue. This is often lacking in more mainstream economic frameworks unless they integrate political theories of justice into their analytical frameworks (E. P. Davis, 2015)

Social and politics as drivers of economic processes are being recognized by the **Institutional Economics** approach. There are two main threads of thoughts which are referred as the Original Institutional Economics (OIE) and the New Institutional Economics (NIE). The former is based on the tradition of Veblen, Ayres, Commons and Mitchell. The latter is based on Ronald Coas's theory of transaction costs and extend its theoretical developments to property rights, public

choice and the theory of the firm. It takes the view that decision making is bounded by time and information in oppose to the neo-classical theorem which assumes unbounded rationality. Tthhat means decision makers do not have the whole picture and a complete set of data points to allow them to act in a rational manner (D.C. North, 1993). OIE defines institutions as prevalent habits of thoughts with respect to particular relations and function to the individual and society while NIE extend that and emphasis on the individual (J. Prada, 2005). Poverty and inequality contribute to bad political choices which impede flawed institutions and policies (Z.D. Caliskan, 2016; M. Dabrowski, R. Gortat, 2002).

1.1.3 The problem of inequality in economic theories

The preceding four decades have been marked by growing inequality. Inequalities in income and wealth present important macroeconomic issues for our time. This increasing economic inequality supports financial instability. Scholars such as S. I. Dragoe believe that if this economic inequality is left untreated, it will pose a significant threat to economic sustainability (S. I. Dragoe, 2016). Economic theories of inequality have been largely quantitative and focused on the relation between inequality and growth. In his *Wealth of Nations* (2007; originally 1776) book, Adam Smith develops the idea of a free market for goods and labor that leads to an increasing division of labor and ultimately to economic growth. This overall product is distributed among the population, so everyone profits from this growth. However, the distribution of this product is not equal but rather proportionate. Smith therefore worked and thought in the framework of a feudal society (G. Guidetti & B. Rehbein, 2014).

As inequality is a very complex and multidimensional phenomenon, each economic approach in this field of study has been advanced by different economists who have shown different approaches and hypotheses over time. Four main economic approaches can be distinguished for inequality: **the classical approach**, **the neoclassical approach**, **the modern approach**, and **the unified theory** (O. Galor, 2009).

The classical approach puts forward the hypothesis that inequality is beneficial for economic development, leading to the notion that inequality is a necessary byproduct of economic growth (P. Aghion et al., 1999; R. Benabou, 1996; E. Quintin, 2008)**.** However, the classical approach relates to the post-industrialization period (Keynes M. John, 1920; K. Nicoals, 1955). It suggests that increases in aggregate savings and capital accumulation enhance the development

process. In classical models, economic growth depends mainly on the rate at which nations accumulate productive resources, a factor that traces to aggregate saving rates. The classical view long dominated economic thought, emphasizing that policies designed to reduce inequality would lead to adverse consequences for economic growth (E. Quintin, 2008; O. Galor, 2009).

The classical approach was dismissed with the advent of **the neoclassical approach,** a paradigm that dominated the field of macroeconomics. The neoclassical approach rejects the relevance of heterogeneity and consequently the distribution of income. It understands the relationship between inequality and economic growth as capturing the effect of the growth process on the distribution of income (O. Galor, 2009). Neoclassical theory focuses on an individual's maximization of his or her expected income, assuming that markets are complete and well-functioning. The traditional neoclassical model emphasizes competitive markets for fixed skills (C. Jencks, 1980). A basic principle of neoclassical theory is the belief that the presence of competition will eventually lead society to an optimal allocation of resources. Under such circumstances, equally productive workers would receive the same wage. The neoclassical theories are supported by empirical evidence that demonstrates that income distribution has a significant impact on the growth process (O. Galor, 2009).

Unlike the classical viewpoint, which underlined the beneficial effects of inequality for the growth process, **the modern perspective** highlights the potentially adverse effects of inequality on the growth process (O. Galor, 2009). Over the past two decades, researchers like Roberto Perotti (1993), Thorsten Persson (1994), and Guido Tabellini (1994) have generally found a negative relationship between income inequality and subsequent economic growth. Empirical findings suggest that greater equality could foster growth (E. Quintin, 2008). Galor and Zeira (1988, 1993) also advanced a novel viewpoint when they analyzed the important role that heterogeneity, and thus income distribution, plays in establishing economic activity and fostering economic growth. In contrast to the classical hypothesis, which emphasizes the advantages of inequality for economic growth, Galor and Zeira put forward the hypothesis that inequality in the presence of credit market imperfections can be detrimental to human capital formation and economic development (O. Galor, 2009).[7] Modern economics that explicitly addresses the issue of economic inequality was

[7] The **credit market imperfection** approach for the study of income distribution and economic growth has explored the implications and robustness of the effect of inequality on the process of development in the presence of credit market imperfections (Galor, O, 2009).
https://pdfs.semanticscholar.org/d43b/bda7d1db166d23a105b8261b5d33c4268b15.pdf

developed by Kuznets (1955). Based on empirical evidence, Kuznets shows that inequality tends to rise in the early stages of economic development as a consequence of industrialization. It then declines in later stages as the system of capitalism matures. In this way, income inequality demonstrates the classical inverted-U-shape trend over time. It is therefore not growth per se that gives rise to economic inequality but rather the nature of that economic growth (G. Guidetti, 2014).

It follows, however, that increases in inequality correlate to higher growth due to the savings effect (where the rich save more than the poor) and the incentives effect (where in the absence of redistributive policies, talented people can benefit from the fruits of their labors). Inequality can also foster growth, however, because new industries typically require large initial investments. If a credit market functions poorly, a society's savings may not be efficiently translated into investments. In such an environment, a high concentration of wealth in fewer investors may help overcome these impediments and stimulate growth by bringing capital-intensive industries into being (Erwan Quintin, 2008).

The unified theory: The modern perspective on the relationship between inequality and economic development lacked a unified hypothesis for the role of inequality in the development process, particularly in light of the differences between the classical and modern approaches. The central hypothesis of the unified approach stems from the recognition that the accumulations of human and physical capital are fundamentally asymmetric. In contrast to physical capital, human capital is inherent in humans, and physiological constraints subject its accumulation at the individual level to diminishing returns. This asymmetry between the accumulations of human and physical capital therefore suggests that while credit constraints are largely binding, a more equitable distribution of income will be conducive for human capital accumulation. Therefore, in economies where the return to human capital is relatively low, inequality is beneficial for economic growth. In contrast, in economies where the return to human capital is relatively high and credit constraints are largely binding, equality is beneficial for economic growth (O. Galor, 2009).

1.1.4 Welfare economics: inequality, poverty and hunger

The world economy is undergoing changes in almost every country as it moves toward freer markets. Nations belonging to the Organization of Economic Cooperation and Development have privatized state-owned industries, deregulated private industry, and freed international trade and capital movements, thus expanding their influence and competition in world markets. Such economic activity has a multiplier effect on the social order in developing countries. The level of

prosperity and quality of living standards are some of the economic issues of interest. Therefore, this subsection focuses on how the concept of welfare economics influences various problems, such as inequality and the prevalence of poverty and hunger. In addition, it discusses how welfare economy theories aim at a social optimum.

1.1.4.1 The history and fundamental theorems of modern welfare economics

Modern welfare economics has presented different theories over its history, with Adam Smith (1776) playing an important role in the development of welfare theory. He created the idea of the "invisible hand," which is one of the most fundamental equilibrating relations in economic theory. It was first introduced in his book *An Inquiry into the Nature and Causes of the Wealth of Nations*. The term "invisible hand" is a metaphor for how, in a free market economy, self-interested individuals operate through a system of mutual interdependence to promote the general benefit of society. He sees the invisible hand as being embodied in a central planner who guides the economy to a social optimum. Adam Smith also played an important role in the development of welfare theory in his attempt to explain the "Water and Diamond Paradox," which is also known as the paradox of value. Adam Smith made a distinction between "value in use" and "value in exchange," which was not a trivial insight. The value in exchange is not enough to measure welfare, which is fundamental to answering the Water and Diamond Paradox.[8]

Another important step in welfare theory development concerns Leon Walras (1874), who introduced the general equilibrium system based on the fundamental principles of utility maximization and profit maximization firms. However, he still misses an idea of how to rank different general equilibrium allocations, as well as how to deal with distributional issues. Vilfredo Pareto took the distributional issue quite some way further, however, making two key contributions to the existing theory. First, he realized that it was not necessary that utility should be cardinal, something that was implicit in 19th century economics. His most important contribution was a partial ordering that admitted inter-personal welfare comparisons.[9] This partial ordering later became known as the *Pareto criterion*. Pareto proposed that welfare increases if some people gain and nobody loses. English economist Arthur Cecil Pigou introduced in *The Economics of Welfare*

[8] **The paradox of value**, which is also known as the **diamond–water paradox**, is the apparent contradiction where water is generally more useful than diamonds in terms of survival, yet diamonds command a higher price in the market. http://www.efi.int/files/attachments/e45/meetings/31hanemann.pdf

[9] A **partial ordering** is a relation defined on a set, having the properties that each element is in relation to itself, the relation is transitive, and if two elements are in relation to each other, those two elements are equal. http://www.dictionary.com/browse/partial--ordering

(1920) the concept of modern welfare theory. His contribution related to the distinction between private and social cost, which are termed as externalities. Pigou stressed that in the presence of externalities, the market system is inefficient, and this may justify government intervention in the market (T. Aronsson et al., 2007).

A complete version of modern welfare theory had to wait until the publication of A. P. Lerner's (1934) paper and his book *The Control of Economic Resources* (1944), however. Lerner was the first to describe the system as a whole and showed that a competitive market economy generates a Pareto optimal allocation of resources. This finding became known as the **First Fundamental Theorem of Welfare Economics** (T. Aronsson et al., 2007; J. R. Hicks, 1975).

J. Eatwell et al. (1987) presented the theoretical side of welfare economics as organized around three main propositions. **The First Theorem** answers the question of "In an economy with competitive buyers and sellers, will the outcome be for the common good?"[10] **The Second Theorem**, meanwhile, addresses the following question: "In an economy where distributional decisions are made by an enlightened sovereign, can the common good be achieved by a slightly modified market mechanism, or must the market be abolished altogether?" **The Third Theorem** focuses on a different general issue, namely defining social welfare and common good, whether through the market, a centralized political process, or a voting process. It answers the following question: "Does there exist a reliable way to derive from the interests of individuals, the true interests of society, regarding, for example, alternative distributions of wealth?" (J. Eatwell et al., 1987, p.889-890).

The first welfare theorem is actually a mathematical restatement of Adam Smith's famous "invisible hand." It illustrates a relationship between the two concepts: Pareto optimality and competitive equilibria. The First Fundamental Theorem of Welfare Economics, which is also known as the "Invisible Hand Theorem," says that any competitive equilibrium leads to a Pareto efficient allocation of resources. [11, 12] The main idea behind the first theorem is that markets lead

[10] **The first welfare theorem** is helpful only in identifying situations where intervention may lead to a greater efficiency.

[11] **Competitive equilibrium:** A market system is in competitive equilibrium when prices are set in such a way that the *market clears*, or in other words, *demand and supply* are equalized. At this competitive equilibrium, firms' profits will necessarily have to be zero, because there will otherwise be new firms that, attracted by the profits, would enter the market and increase supply, thus pushing prices down. Following the *first fundamental theorem of welfare economics*, this equilibrium must be *Pareto efficient*. Both will have a fundamental relation as a mechanism for determining optimal *production*, consumption, and exchange. http://www.policonomics.com/general-equilibrium/

[12] **Pareto efficient:** This *efficiency criterion* was developed by *Vilfredo Pareto* in his book *Manual of Political Economy* in 1906. An allocation of goods is Pareto optimal when there is no possibility of redistribution in a way

to social optimum, so with no intervention required by government, it should adopt only "laissez faire" policies.[13] However, those who support government intervention say that the assumptions needed to make this theorem to work are rarely observed in reality. Moreover, it must be noted that a Pareto efficient distribution is a situation where someone holds every good while the rest of the population holds none. Such a situation can hardly be considered as perfect under any welfare definition (K. T. Kok Tan, 2008).

The First Welfare Theorem is often coupled with the Second Welfare Theorem and collectively referred to as the *Fundamental Theorems of Welfare Economics*. The First Welfare Theorem states that a competitive equilibrium is Pareto optimal. The second one begins with a Pareto optimal allocation and concludes that there will be a suitable price system, such that there will be an equilibrium. Therefore, the **Second Fundamental Theorem of Welfare Economics** goes as follows: Any efficient allocation can be attained by a competitive equilibrium, given the market mechanisms leading to redistribution. This theorem is important because it allows the separation of efficiency and distribution matters. The **Third Fundamental Theorem** of Welfare Economics, in its short version, is as follows: There is no Arrow Social Welfare Function that satisfies the conditions of universality, Pareto consistency, neutrality–independence–monotonicity, and non-dictatorship.[14] Arrow was concerned with the logic of how individual preferences are transformed into social preferences (J. Eatwell et al., 1987; J. Stiglitz, 1991).

J. Eatwell et al. (1987) point out that the first theorem by itself pays no attention to extremes of poverty or inequality, while the second and third theorems rely on proper mechanisms for the redistribution of wealth. For P. J. Hammond (1992), the first welfare theorem serves as a double-edged sword in that it can be used to argue both for and against market intervention. The first welfare theorem is the "invisible hand," which means that as long as each participant of the

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where at least one individual would be better off while no other individual ends up worse off. http://www.policonomics.com/pareto-optimal/

[13] ***Laissez-faire*** is a French expression that translates as "to let do, let pass", that is letting things work on their own. In a sense it sums up the economic doctrine of *physiocracy (the* government of nature), expressing that there is a natural order of things, with its own laws, and it is best to let them run by themselves without laying restrictions.

[14] **Arrow Function**: Arrow imposed some reasonable conditions on its function. There are four such conditions: (1) **Universality**—the function should always work, no matter what individual preferences might be; (2) **Pareto consistency**—if everyone prefers x to y, then the social preference ought to be x over y; and (3) **Independence**—social preference regarding x and y must be exactly the same under the two alternatives, and in particular, should individuals change their minds about a third "irrelevant" alternative, it should not affect the social preference regarding x and y; and (4) **Non-dictatorship**—there should not be a dictator, meaning that a person is a dictator if society always prefers exactly what he or she prefers.

economy maximizes utility or profit for him or herself, the best possible outcome for all participants as a whole will emerge, leading to the conclusion that non-intervention benefits the market.

Some researchers argue that since those very conditions never emerge in the real world, the First Welfare Theorem never comes into play, so we never reach a Pareto optimal result from a competitive equilibrium unless there is intervention in the markets. The two Welfare Theorems assure us that under the conditions of the theorems, a set of competitive equilibrium allocations and a set of Pareto optimal allocations overlap exactly, such that finding competitive equilibria gives us a set of solutions that optimization problems can address with dynamic programming. The Second Welfare Theorem is also encouraging because it indicates that under a fixed set of conditions, solutions to dynamic programming models are supportable as competitive equilibria. Therefore, under these conditions, all optimizations can be found by finding competitive equilibria (P. J. Hammond, 1992).

1.1.4.2 Welfare economics theorems as justification for public intervention

It is interesting how these fundamental theorems of welfare are reflected in the global economy and the problems of poverty, hunger, and inequality. S. Dercon (2003) argues that serious market failures and asset inequalities are an important reason for poverty's persistence. In addition, economic-development market failures, such as credit market failures, contribute to poverty and poverty traps. Economics teaching emphasizes that an economy, when left to its own devices, will achieve the most efficient outcome. This view is reflected in **the first welfare theorem,** which states that any competitive equilibrium will lead to an efficient allocation where no one can be made better off without making someone else worse off. However, the conditions for competitive equilibrium are very stringent. **The second welfare theorem**, meanwhile, appears to open the door to the redistribution of endowments by showing that any efficient allocation can be achieved as a competitive equilibrium for a particular distribution of initial resources. In other words, one can separate efficiency considerations from equity ones by first redistributing the initial resources and then letting the markets do their job. Nevertheless, the main issue here is to find a way to redistribute wealth without affecting the process that leads to a competitive market outcome. Actually, the notion that redistributions exist with no effect on incentives is found to be wrong, so the question is this: Where does this leave the poor? B. C. Greenwald et al. point out that many economists have argued that the underlying assumptions of these welfare theorems are basically flawed and that with market failures, the principle of interventions that may be efficient is well

established (B. C. Greenwald et al., 1986). For C. Wilson and P. Wilson (2006), the subset outcomes of interventions, such as asymmetric information, are particularly relevant for the poor. Market failures particularly hurt the poor, affect their living conditions, and exacerbate their poverty. This scenario happens when efficiency reduces in a way in which the poor use their assets while leaving the rich unaffected.

What is more, M. Eswaran et al. (1986) point out that a market failure mainly affects and hurts the poor, but this is more than an equity issue. It could be interpreted as meaning that the poor are not able to use their assets as efficiently as the rich can. M. Eswaran et al. developed a simple model to illustrate such implications. The simplified version goes as follows:

> *Consider a village with farm households, each with differing amounts of land and labor. The efficient technology to produce agricultural products involves using land, labor, and fertilizer as essential inputs. Labor, land rental and fertilizer markets are assumed to work efficiently, at the governing price, and they can all be obtained without restriction. However, the credit market is not perfect. The result is that credit can only be obtained using land as collateral, while all inputs have to be paid for in cash. The nature of agricultural production implies that output is only obtained at the end of the season while inputs need to be applied early in the season. In short, there is a need for working capital to acquire inputs if needed (S. Dercon, 2003, p.4).*

Basically, the land-rich farmer can easily get credit to buy fertilizer and hire labor, as well as purchase extra land to make sure the inputs are used as efficiently as possible. The land-poor farmer, meanwhile, needs to find other ways of raising cash to improve farm efficiency, such as earning cash from working on other farmers' land or even renting out some of his limited land. Therefore, under general conditions, the land-poor farmer will be using his assets (his land and labor) less efficiently than his land-rich counterpart will. In addition, the poorer farmer will be using less fertilizer than would be optimal and have insufficient labor for the area of land. The poverty of the land-poor farmer, in terms of assets, then leads to inefficiency. In this example, asset inequality combined with market failure results in differences in efficiency between the poor and the rich. The rich do not just earn more income because they have more assets—they can also use them more efficiently. Thus, market failures exacerbate the initial inequality between rich and poor. Better working credit markets and/or more equal asset distribution can be efficiency and equity enhancing. There is some quite good evidence that similar processes are common in agricultural

settings and often linked to credit market failures. A correlation between cultivated land area and output per hectare is commonly observed in developing countries. The average output per hectare is typically smaller for the poorer farmers than it is for their richer counterparts. The above model is not restricted to agricultural activities, however. It is also applicable when access to profitable activities requires some initial investment, so those with limited access to credit markets are often excluded (S. Dercon et al., 1996).

This model therefore begins with some inequality in assets. It shows how those with greater wealth can earn higher returns and thus accumulate further wealth, while activity among the poor is characterized by lower returns, so they may be prevented from accumulating wealth. A. Banerjee et al. (1993) show the adverse impact of asset inequality on growth when linked to credit market failures. Profitable activities are closed off for those with limited assets, so they become trapped in poverty, while the asset rich can improve their position in the occupational ladder. A poverty trap is an equilibrium outcome and a situation from which someone cannot escape without outside help, such as through redistribution or aid. A fundamental change in the functioning of markets could also help people to escape poverty traps. O. Galor et al. (1993), P. Aghion et al. (1997), and R. Benabou (1996) suggest that poverty traps, overall efficiency, and growth losses are due to poverty and inequality combined with credit market failure. This means that some people are unable to exploit growth-promoting opportunities for investment, not just in terms of physical capital or profitable activities but also in human capital.

The development policy community has noticed these poverty-perpetuating mechanisms, and interventions in credit markets have been widespread for a number of decades. The principle of intervention involves providing credit to poorer groups at subsidized rates. Such interventions are well founded, and in principle, this type of intervention can be both equity and efficiency enhancing. Large-scale credit programs meant for the poor have often been characterized by huge inefficiencies and appropriation by richer groups. Such behavior was seen with the Integrated Rural Development Program (IRDP) in India and similar programs in Africa (T. Besley, 1994).[15]

[15] The **Integrated Rural Development Program** (IRDP) is a rural-development program of the Government of India that was launched in financial year 1978 and extended throughout India by 1980. The IRDP was proposed to provide self-employment opportunities to the rural poor through provision of capital subsidies and bank credit in order to help them to acquire productive, income-generating assets and training to upgrade their skills. http://www.preservearticles.com/2012020322532/short-notes-on-integrated-rural-development-programme-in-india.html

The significance of market failures lies in how they disproportionately affect the poor and limit their ability to better their status, so they may remain stuck in poverty. There are different market failures. While we focused on credit market failures, there exist other kinds of market failures, such as lack of insurance, which largely affects the poor and interacts with poverty and inequality. S. Dercon (2003) concludes that, even if one accepts that poverty results from an interaction between inequality and market failures, it is not easily established whether it is better to address the inequality and poverty or the market failure first.

1.2 Poverty and inequality in the sustainable development paradigm

1.2.1 Origin of the sustainable-development concept

Sustainable development is an important concept to introduce, because it helps to shape the international agenda and the community's attitude toward economic, social, and environmental development. In addition, this concept supports strong economic and social development, particularly for people with low standards of living.[16] At the same time, sustainable development emphasizes the importance of protecting the natural resource base and the environment (J. Robinson, 2004; M. Lehtonen, 2004).

In 1987, the Bruntland Commission published its *Our Common Future* report in an effort to link the issues of economic development and environmental stability. This provided the often-cited definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). This concept of sustainable development aims to maintain economic advancement and progress while protecting the long-term value of the environment. It also "provides a framework for the integration of environmental policies and development strategies" (WCED, 1987). The World Commission on Environment and Development (WCED) also supplemented this with a few comments, pointing out that 1) a large proportion of the world's population was still living in poverty; 2) there were large disparities in patterns of resource use between richer and poorer countries; and 3) global ecosystems were already suffering acute stress (WCED, 1987, p. 33). The WCED called for a reorientation of economic activity in order to address poverty and underdevelopment in developing countries.

[16] **Strong economic** development involves a diversification of income sources for farmers, which helps to ensure a strong economic and social base for rural development.

The definition for sustainable development provided by the Bruntland Commission emphasizes the fair distribution of natural resources among different generations and people, and it also shows a positive consensus among the environmental, social, and economic dimensions. In other words, sustainable development is not about choosing between environmental protection and social progress but rather an ambition for achieving an economic and social development that is compatible with environmental protection (H. Bossel, 1999; J. Meadowcroft, 2000; R. Ciegis et al., 2009; A. M. Teodorescu, 2015). Sustainable development is a contested concept with a wide range of meanings and definitions. Indeed, the economic literature offers over a hundred definitions, mostly oriented toward specific environmental, economic, or civil sectors (WCED, 1987; D. Pearce et al., 1989; J. Pezzey, 1989; R. Ciegis et al., 2009). Researchers recognize sustainable development as a new paradigm for development, and this has led to the development of new economic theories. Theoretical and practical issues arise, however, because of the overlap between environmental, social, and economic analysis, with major implications for macroeconomic policy (L. Sharachchandra, 1991). Particular focus has been placed on the idea that issues concerning sustainable development connect to the concepts of "sustainability" and "development." In economics, development means ensuring that the per capita income of future generations is not lower than that of the preceding generation (R. Ciegis et al., 2009). In a similar way, the element of "sustainability" has its own interpretation. Economic models propose sustaining opportunity, usually in the form of capital. According to the classic definition formulated by economist Robert Solow, we should think of sustainability as an investment problem in which we must use returns from the use of natural resources to create new opportunities of equal or greater value. The economic sustainability element is based upon Solow's[17] amplified theory on capital convertibility and Hicks-Lindahl's concept of maximum income, which can be acquired by saving essential wealth (capital) resources for the benefit of future generations and implementing the principle of fair distribution among generations. Economic sustainability seeks to maximize the

[17] **Solow** showed that given a degree of substitutability between human capital and natural capital, one way to design a sustainable consumption program for an economy is to accumulate man-made capital. When this accumulation is sufficiently rapid, the effect from the shrinking exhaustible resource stock is countered by the services from the increased human capital stock. Hartwick's rule is often referred to as "invest resource rents," where "rent" is payment to a factor of production (in this case capital) in excess of that needed to keep it in its present use. This requires that a nation invest all rent earned from the exhaustible resources currently extracted.

flow of income and consumption that could be generated while at least maintaining the stock of assets (or capital) that yield beneficial outputs. (R. Ciegis et al., 2009; R. M. Solow, 1993).

1.2.2 Poverty reduction in the context of sustainable development

By utilizing economic tools, early theorists proposed that policies to protect the environment could also promote innovation and ultimately turn a profit. In 1920, Arthur Pigou noted that the presence of incidental, uncharged services act as a barrier in achieving equilibrium in the market. In his work entitled *The Economics of Welfare,* he noted how the divergence between marginal private costs and benefits and marginal social costs and benefits creates "externalities" (A. Pigou, 1920). In order to correct these market failures, Pigou proposed a tax on these activities. By imposing this charge, which is called a Pigouvian tax, the market price will more accurately reflect the comprehensive costs and benefits of the activity (M. E. Porter et al., 1999). Meanwhile, according to J. C. Dernbach (1998), "effective governance requires a nation to consider and protect the environment and natural resources on which its current and future development depend. Any other approach is self-defeating. The connections between the environment and development thus provide a powerful rationale for environmental protection: enlightened self-interest" (J. C. Dernbach, 1998, p.20). This inherent dependency between the long-term stability of the environment and the economy is the foundation for the field of sustainable development.

Porter (1995) similarly proposes that sustainable-development policies look to tackle the sources of environmental degradation rather than just the symptoms while concurrently providing opportunities and incentives for economic advancement (M. E. Porter et al., 1995). More recently, nations have moved toward implementing these market-based mechanisms to internalize this concept. In other words, they seek to ensure sustainable development while reducing poverty and inequality (R. Emas, 2015). Different experiences with poverty reduction inevitably lead to the fact that "people must be the center of any strategy, as both the means and the ends of poverty reduction" (S. Sandstrom, 1994, p.31). In addition, any poverty alleviation must be at the core of all development objectives and should determine policies and investments (S. Sandstrom, 1994). Meanwhile, the UN document *Our Common Future* emphasizes that a world in which poverty and inequity are endemic will always be prone to ecological and other crises. It adds that sustainable development requires meeting the basic needs of all while extending them the opportunity to satisfy their aspirations for a better life (WCED, 1987).

For L. Qian-Qiana et al. (2015), poverty reduction and sustainable development are inseparable, because poverty reduction is the premise for sustainable development (L. Qian-Qiana et al., 2015). Therefore, poverty reduction, in the context of sustainable development, requires economic growth and investment in people, two processes that are mutually reinforcing (S. Sandstrom, 1994). For example, good education, health, nutrition, and family planning are necessary if the poor are to contribute to, and participate in, economic growth. For poverty reduction programs to be effective, however, they should also be environmentally sustainable. Most poorer people suffer from common problems, such as unclean water, inadequate sanitation, and soil erosion. At the same time, they cannot invest in new resources that would yield them positive returns in the future, so they have few options other than to use the available natural resources (S. Sandstrom, 1994; L. Qian-Qiana et al, 2015). The essential needs of most people in the developing countries are food, clothing, shelter, and jobs, with many unable to attain these things. Meeting these essential needs depends in part on achieving the full growth potential with sustainable development, which clearly requires economic growth in places where such needs are unmet. Growth along is not enough, however. Sustainable development involves more than that—it requires a change in the nature of the growth to make it less material and more equitable in its impact. It also should reduce the degree of vulnerability to economic crises. Growth must therefore be the main issue in developing countries, because this where economic growth, the alleviation of poverty, and environmental conditions are most directly linked. However, developing countries are part of the world economy, so they depend upon the level and pattern of growth in industrialized nations (WCED, 1987).

Sustainable development deals with several interrelated issues simultaneously, including economic development to alleviate poverty and inequality. This aims to provide employment; invest in human capital, such as by stabilizing population growth and providing opportunities to improve wellbeing; protect natural resources by giving the poor and marginalized alternative livelihoods; and provide support for improved technologies and practices that are appropriate and efficient. Therefore, the operational implications of this concept point to the need for policy to address these issues. A prominent one is the economist's view, which focuses on methods to maximize human welfare within the context and constraints of existing capital stock and technologies. The ecologist's framework, meanwhile, emphasizes the preservation ecological subsystems as something critical for the overall stability of the global ecosystem, including

maintaining the reliance and dynamic adaptability of natural support systems. Finally, the sociologist's view emphasizes that human beings are the key factor in achieving sustainable development. In this respect, insufficient attention to social factors in the development process negatively affects programs and projects (I. Serageldin et al., 1994; L. Qian-Qiana et al., 2015).

Therefore, according to this concept, the best way to address poverty and the inequality problem is to integrate sustainable development into the development agenda and operational planning steps. Different tools exist to achieve this process of economic advancement while embracing the social impact and progress. The tools used to measure inequality and poverty will be discussed in the next section.

1.3 Hunger and food and nutrition in the economic perspective

1.3.1 Definition of hunger and food and nutrition security

As 20th century policymakers address the hunger problem, food and nutrition security (FNS) becomes a key concept in the issue. The definition of hunger provides a clear conceptual basis for what hunger should mean when measuring food insecurity. This then allows researchers and policymakers around the world to deal with the hunger problem on a more objective basis. Without such a clear and standard operational definition, there would be major obstacles to estimating the extent of the problem and finding agreeable operational ways to reduce it (G.S.Wunderlich et al., 2006).

Hunger is a multidimensional phenomenon, so it is problematic to define. Most works relating to hunger never explicitly define this term. Where a definition is used, it usually involves various phenomena associated with situations, such as physical sensations (K.L. Radimer et al., 1990). For A. Weisfeld et al. (2008), although hunger can be, and often is, described in terms of its medical implications, hunger can also be viewed as being representative of the different circumstances that caused it. Such circumstances include, but are not limited to, poverty, resignation, and gender discrimination. From the most comprehensive perspective, hunger is described as a feeling of discomfort associated with the body's signal for a lack of food. A. Weisfeld et al. admit that this is a problematic concept. E. Masset (2011), meanwhile, criticizes definitions such as that given by the Oxford English Dictionary (1999), where hunger is described as an "uneasy and painful sensation caused by the lack of food." Masset says that this definition's focus on sensation can hardly be measured in a meaningful way. What is more, focusing on the

sensation distracts attention from the causes and consequences of hunger, such as poor health, low productivity, poor physical and cognitive development, and mortality. Hunger can be defined in different ways, such as by its causes, its consequences, or a combination of the two. J. Dreze and A. Sen in 1989, argue that both ways are equivalent, and such an approach is not a new one. There has always been a tradition in social sciences of describing fuzzy concepts by their consequences. For example, poverty indicators are not based on the determinants, such as income and assets, but rather on its consequences, such as consumption expenditures. Similarly, education is measured by literacy rates rather than by school attendance or the availability of schools. In contrast, the traditional way of measuring hunger has focused on the lack of food. Food availability and food intake have therefore been long used as indicators of hunger (FAO, 1987; E. Masset, 2011).

Despite the fact that the hunger phenomenon manifests on a global scale, there is no acceptable definition, nor is there any acceptable method to measure or estimate its level. Few studies step up to the challenge of defining hunger. According to K.L. Radimer et al. (1990, p. 1545), "the definitions of hunger varied widely and the measures of hunger were generally indirect and the definitions and measures often lacked congruence." The U.S. President's Task Force on Food Assistance distinguishes between different hunger definitions: First, there is a scientific and clinical definition in which hunger represents "the actual physiological effects of extended nutritional deprivations." The second definition relates to a more social phenomenon instead of medical conclusions. Here hunger is defined as "the inability, even occasionally, to obtain adequate food and nourishment" (G.S. Wunderlich et al., 2006, p. 34). Definitions of hunger put forward by large organizations like the FAO are very important for their role in eradicating hunger. The FAO has created a definition, measuring concepts, and measurement methodologies for hunger. Measuring concepts, namely the estimation of the frequency and severity of hunger, include the hunger index, which will be discussed later in this chapter.

A variety of hunger definitions representing different approaches appear in the literature. These differing definitions emphasize the disagreement that exists among them, even though they all have the shared goal of eradiating hunger. The four definitions of hunger presented below are the most well-known.

LSRO, USA (1990):[18] One of the most prominent and comprehensive attempts to define hunger was made by LSRO of the USA in 1990. It sought to find an agreeable conceptual definition and an appropriate measurable concept for hunger that would be relevant to the interests and needs of the United States. With a panel of experts, LSRO prepared a report containing what later became the consensus definitions for the following three terms: *food security*, *food insecurity*, and *hunger*. Food security was defined as the ability to obtain sufficient amounts of nutritionally adequate and safe food at all times to enable an active and healthy life, as well as the ability to purchase food in a socially acceptable way. Food insecurity, in contrast, was defined as the limited or uncertain availability of nutritionally adequate and safe foods and/or a limited or uncertain ability to acquire acceptable foods in a socially acceptable way. Hunger was defined as the unpleasant feeling or pain resulting from food shortages. Examining hunger in terms of food security has made it possible for researchers and policy makers in the United States to deal with hunger issues on a more objective basis. The definitions and ideas of LSRO's initiative have provided a platform for the DHHS to develop definitions for food insecurity and hunger that were suitable for use in large national population surveys.[19] In January 1994, the United States Department of Agriculture (USDA) and the DHHS adopted the following conceptual definition of hunger: "an island comfort, illness, weakness, or pain caused by prolonged lack of food involuntary" (G.S. Wunderlich et al., 2006, p.76). For T.W. Anderson (1990, p. 1575, 1576), however, hunger is a consequence of food insecurity. He defines hunger as "the uneasy or painful sensation caused by a lack of food; the recurrent and involuntary lack of food."

FAO (Rome, 1987). The FAO defines hunger as "the inability to maintain body weight and consequently suffering from lack of energy." It is a condition that arises when the dietary energy consumption is less than a predetermined threshold. Here, the threshold is measured in terms of the number of kilocalories and calculated according to age, height, activity level, and medical conditions. The minimum requirement per person was calculated at approx. 1,800 kilocalories daily (FAO, 1987). In 1996, the FAO defined hunger in terms of food security, where people have physical and economical access to enough safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996).

[18] **LSRO** is the Life Sciences Research Office of the American Society for Nutritional Sciences. It provides scientific assessments of topics in biomedical sciences. Reports are based upon comprehensive literature reviews and the scientific opinions of knowledgeable investigators engaged in work in relevant areas of biology and medicine.

[19] **DHHS** is the Department of Health and Human Services.

WHO: The World Health Organization defines hunger as a syndrome resulting from the interaction between poor diet and disease (WHO, 1995).

CCHIP (2011):[20] The CCHIP defines hunger as the mental and physical condition that comes from not eating enough food due to insufficient economic, family, or community resources. It is the extent of hunger determined by monitoring groups of people and the food items they consume in a 24-hour period. A grocery bag is set containing 12 food groups and 45 different food items (D. Labadarios et al., 2011; C. A. Wehler et al., 1992).

Food and nutrition security (FNS) is a new and important concept in reducing poverty, and it has evolved significantly over the recent decades in both theory and practice. There are two perspectives for addressing food security: One believes in raising the volume of the production as the core answer to hunger. This concept focuses on the agricultural side, implying that food insecurity must be addressed by producing more food. In contrast, S. Maxwell et al. (2003) and T. Lang et al. (2004) challenge this concept with a new perspective based on a more complex analysis. It takes a food-system approach, where social and ecological concepts are required to address a complex array of problems. In this concept, our world's food system is unsustainable, as is strikingly clear from the impacts that our consumption and production patterns have on environmental degradation and climate change (S. Maxwell et al., 2003; T. Lang et al., 2004). Food and nutrition security is among the most basic of human needs. The 21st century's core task is to create a sustainable food system with a more coherent policy framework than the existing one. Its goal is to integrate the social, environmental, and economical sources into one policy (FNS, 2012).

Over recent decades, FNS has evolved significantly in both theory and practice. Global FNS has existed for over 50 years, and it has been given several definitions and paradigms over the years. Following the Hot Springs Conference of Food and Agriculture in 1943, the concept of a "secure, adequate, and suitable supply of food for everyone" was internationally accepted. Donor countries, such as the USA and Canada, started to dispose of their agricultural surpluses overseas. The success of the green revolution of the 1980s has also helped increase the volume of food

[20] **CCHIP** is the Community Childhood Hunger Identification Project, which is regarded as a model for measuring hunger in low-income families. The definition of hunger offered by CHHIP focuses on food insufficiency due to constrained resources. The CCHIP's goal was to construct a measure of hunger appropriate for the socioeconomic conditions of the United States. The measure is part of a survey instrument developed to document the prevalence of hunger among low income families having at least one child under the age of 12 (A.C. Wehler et al., 1992). The community childhood hunger identification project: A model of domestic hunger—Demonstration project in Seattle. Journal of Nutrition Education, 24(1): 29S-35S.
http://www.sciencedirect.com/science/article/pii/S002231821280135X

production and food availability. It was first recognized that food catastrophes were not a result of food production deficiency but rather a result of sharp declines in the purchasing power of specific social groups. Food security was therefore broadened to include both physical and economic access to the food supply. In the 1990s, concrete plans were formulated to eradicate, or at least reduce, hunger and malnutrition drastically. These plans focused on ideas like a human's right to adequate food and nutrition, building a committee of national governments with a more proactive role, and reducing international and public support by donor agencies (L. Weingärtner, 2004).

The fundamental goal of FNS is to achieve human rights, particularly the right to food. It focuses mainly on the "**availability,** which refers to the need for enough adequate food to be produced and efficiently distributed, to the **access of,** which refers to the ability to produce one's own food or have the purchasing power to buy it, to the **utilization and quality of**, meaning food must be adequate for utilization from a nutritional, sanitary, sensory and socio-cultural point of view, which also address the issues of intra-household distribution, and lastly the **stability of**, referring to security of access and incorporates issues such as price stability, securing incomes for vulnerable populations, and the need to ensure the long-term sustainability of the FNS" (L. Weingärtner, 2004, p.4). The goals of FNS are achieved by addressing all three dimensions of sustainability, namely the economic, social, and environmental aspects and their links. On the practical side, coherence should be found between actions focusing on human rights, human development, and environmental sustainability.

FNS draws our attention to two important concepts: food security and nutrition security. These two complex phenomena are interrelated, and they are the outputs of several factors. Their close connection means we can combine them into one umbrella term: food and nutrition security.

Food security has long been the goal of many national and international organizations, with its definition and related concepts having evolved and expanded over time. In fact, more than 200 definitions and 450 indicators exist for food security. Following the world food crisis of 1973, the definition of food security was narrowed down to the availability and stability of the food supply to national and global markets. During the 1990s and 2000s, the focus of attention was on health, concentrating on safe and nutritious foods that specific groups of people need. In 1992, S. Maxwell and T. R. Frankberger presented the generally accepted definition of food security as the secure access at all times to sufficient food for a healthy life (S. Maxwell and T.R. Frankenberger, 1992). In 1996 and in 2009, the World Food Summit on Food Security adopted the following definition:

"food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO 2009, FAO 2012; U. Lele et al., 2016).[21] Food security is results from a food system that operates efficiently and supports the four dimensions presented by the WFS in 1996: availability, access, stability, and utilization (L. Weingärtner, 2004).

Food security and **nutrition security** are related yet distinct concepts. Food security refers to having sufficient amounts of the right food at all times, and the fulfilment of this depends upon the global and local availability of food, a household's or individual's access to food, and proper utilization of food. Nutrition security, meanwhile, refers to having access to a healthy diet that provides all the nutrients needed for a healthy life. Being healthy with a body functioning at its full potential requires such nutrients. The definition of nutrition security has also evolved over time from the multi-sectorial nutrition planning approach in the 1970s and the conceptual framework of the United Nations International Children's Emergency Fund (UNICEF) (2013). [22] Nutrition security was defined by the United Nations System Standing Committee on Nutrition (UNSCN, 2013) as an adequate nutritional status in terms of protein, energy, vitamins, and minerals for all household members at all times. In conclusion, nutrition security implies an optimal nutritional status and demands the existence of three elements: access to adequate food, care and feeding practices, and sanitation and health. In order to ensure a common understanding of the concepts, analysis, and guidelines, the Committee on World Food Security (CFS, 2011) defined some terms that are commonly used. Nutrition security is among these in the Global Strategic Framework for Food Security and Nutrition.[23] Nutrition security is satisfied when food security is combined with a sanitary environment, adequate health services, and proper care and feeding practices to ensure a

[21] https://en.wikipedia.org/wiki/World_Food_Summit

[22] **Multi-sectoral nutrition planning** emerged in the early 1970s as a bold new approach to combating malnutrition in low-income countries. Conceptually elegant and operationally ambitious, it blossomed on paper but collapsed in practice, notwithstanding vigorous promotion by international assistance agencies. https://www.ncbi.nlm.nih.gov/pubmed/12314568

[23] **Global Strategic Framework:** Despite the efforts and commitment of the international community in the Millennium Declaration to halve the proportion of people suffering from hunger by 2015, persistent hunger and malnutrition remains the norm for millions of people. Faced with rising hunger and fragmented governance for food security and nutrition, member states of the Committee on World Food Security (CFS) agreed at its 34th session in October 2008 to embark on an ambitious reform. The CFS Reform, endorsed by all CFS member states in 2009, redefines the CFS's vision and roles, aiming at constituting "the foremost inclusive international and intergovernmental platform for a broad range of committed stakeholders to work together in a coordinated manner and in support of country-led processes towards the elimination of hunger and ensuring food security and nutrition for all human beings."

healthy life (one free from malnutrition) for all household members (M. Wüstefeld, 2013; M. Ruel, 2013; CFS, 2015).

Food and nutrition security remains a significant challenge for millions of people. Agriculture plays a critically important role in increasing the availability and affordability of nutritious food, but the combined concept of food security and nutrition security is proving hard to realize. It is difficult to define policies and programs that will address and support both goals.

1.3.2 Hunger versus inequality and poverty

A study by the FAO (2003) highlights how Asian countries that achieved stronger economic and agricultural growth succeeded in reducing their hunger levels. The FAO therefore suggests that hunger is essentially a poverty problem. This study found that a rapid income growth, sustained for a long period, leads to reduced poverty, better food security, and good nutrition for the population *(UN, 2003). This hints at the strong hunger–poverty relationship, but this does not exist in a vacuum. This subsection analyses* the relationships among the three elements in the equation: hunger, poverty, and inequality. For a better understanding of these relationships, we present a short introduction for each of the contributing elements listed above.

Hunger, beyond being an unacceptable social phenomenon, hints at the existence of inequality. Inequality is often defined as a disparity in distribution or opportunity, especially in terms of status and rights. If exists both within and between countries. Inequality has increased within many countries but especially so within developing countries (M. Ravallion, 2013). A gap between the rich and the poor within particular countries is paralleled by gaps between different countries (M. D. Yates, 2004). L. Granoff et al. (2015) make an important distinction by pointing out that the prevailing economic growth rate does not directly translate into income growth for poorer people. Indeed, the latter is generally lower than the national average (L. Granoff et al., 2015).

Inequality is always a relative term, because it refers to differences between levels of living standards, incomes, and so on. Economic inequality refers to how economic variables are unevenly distributed among individuals in a group, among groups in a population, or among countries. Inequality has two perspectives: the inequality of opportunities, such as unequal access to employment or education, and the inequality of outcomes in the various material dimensions of human well-being, such as income levels, educational attainment, health status, and so on (H. Afonso, 2015). One of the most striking examples of unequal resource distribution is given by the

existence of chronic hunger in some parts of the world. In addition, the recent price crises also indicated the unequal distribution of resources in the world. People in richer countries were not subjected to hunger during the food crisis, because they only spent a relatively small portion of their income on food. In contrast, families in poorer developing countries typically spend up to 80% of their income on food, so price rises lead to hunger on a local level (Humanium, 2015).

In a world of plenty, a huge number of people go hungry. Hunger is about more than food production levels or the population's food demands. The issue does not stand alone, however, and the causes of hunger are related to the causes of poverty, because people in poverty are often unable to afford food. As Anup Shah (2010) points out, one of the major causes of hunger is poverty itself, and among the different determinants of hunger, poverty is one of the most important. Much like hunger, however, poverty is a multifaceted phenomenon. Rather than being simply a lack of income or goods for consumption, poverty is expressed as a deprivation in health, education, nutrition, and security (FAO, 2015).

Poverty indicators are usually linked to the proportion of people whose income is below a particular threshold, the poverty line. In the case of inequality, methods for measuring it examine the distribution of resources, such as peoples' incomes in a population. In both cases, the market economy is failing to generate an income distribution that provides enough for everyone to purchase the food they need, implying that fighting hunger also helps to reduce poverty (FAO, 2015).

Poverty and inequality are directly and indirectly linked to hunger (Anup Shah, 2010). Inequality and poverty also affect each other directly and indirectly through their link with economic growth. What is more, poverty has a strong sensitivity to distribution changes while also responding to possible changes in inequality. These relationships lead to the notion that poverty can be reduced by increasing overall incomes, changing the income distribution, or using some combination of the two. There are links between the absolute and relative measures of poverty,[24] implying that it is impossible to separate poverty from inequality. Poverty, inequality, and growth interact with one another through a series of bidirectional links. For example, inequality can indirectly influence poverty and affect growth, while growth in turn influences poverty. Small changes in income distribution can also have a large effect on poverty (F. Naschold, 2002).

[24] **Absolute and relative measures of poverty:** All measures of poverty contain an element of distribution, differing only in the extent to which they do so (Felix Naschold, 2002).

Such ideas have also been presented by the Overseas Development Institute (ODI).[25] This organization sees poverty reduction as comprising two elements: improving the rate of growth and changing income distribution. The ODI points out that reducing inequality and income disparities are two key factors in reducing poverty (Anup Shah, 2010).

1.4 Measures of inequality, poverty, and hunger

Measures of inequality, poverty, and hunger can influence our understanding, and analyzing each of these phenomena serves various policy purposes. Measurement methodologies have practical relevance to revealing differences within and between regions, ethnicities, genders, and other social groups, as well as supplying information over time. Moreover, they are useful tools for gaining some understanding about the severity of these social problems in developing and other countries.

This study focusses on the hunger problem, specifically in assessing the effects on the level of hunger when using various hunger models. Several different methods can be used to measure the level of hunger, some of which are introduced in this section. For the purposes of this study, as mentioned earlier, we adopted the *Global Hunger Index,* which is a popular leading hunger index. In addition, inequality and poverty measurements are important aspects introduced in this chapter, because these reflect a country's developmental level and are useful when analyzing different aspects of an improvement in the level of hunger. However, this study did not take such a further step.

1.4.1 Poverty, inequality, and hunger: principles of measurement

The various measures for poverty and inequality found in the literature often present one-dimensional indicators. Some of these have become very popular because they are easily understood (PROVIDE, 2003). Inequality is a broader concept than poverty because it is defined over the entire population rather than just the segment below a certain poverty line. Moreover, most inequality measures do not depend on the mean of the distribution, which is a desirable property for an inequality measure (World Bank, 2005).

[25] The **Overseas Development Institute** (**ODI**), which was founded in 1960, is an independent think tank on international development and humanitarian issues. Based in London, its stated mission is "to inspire and inform policy and practice which lead to the reduction of poverty, the alleviation of suffering and the achievement of sustainable livelihoods in developing countries." http://dbpedia.org/page/Overseas_Development_Institute

Various ways exist to measure inequality and poverty, but the most frequently used ones conform to a certain set of axioms that are actually desirable mathematical properties.

Below is a set of axioms (i.e., desirable properties) for an inequality measure, as cited in J. A. Litchfield (1999):

(1) **The Pigou-Dalton Transfer Principle**: An income transfer from a poorer to a richer person should register a rise in inequality, or at least it should not fall.

(2) **Income scale independence**: Inequality measures should be unaffected if there is a uniform proportional change in households' incomes.

(3) **Decomposability**: This requires that overall inequality should be consistently related to constituent parts of the population, such as population subgroups.

(4) **Principle of population**: Inequality measures should be invariant to replications of the population. For example, merging two identical datasets should not alter the distribution**.**

(5) **Anonymity** or **symmetry**: The inequality measure should be independent of any characteristics of individuals (or households) other than their income.

Poverty measures as inequality indices wish to fulfill desirable and measurable properties. Of the six basic desirable properties (A. Coudouel et al., 2002), the first four are invariance properties,[26] and these indicate how various changes in the distribution should not be taken into account by the measure.

(1) **Focus**: a poverty measure should be independent of the income distribution of the non-poor.

(2) **Symmetry** and (3) **Population Invariance:** These two properties are important for ensuring that the measure is based on an anonymous distribution and not on the income recipients' names or the population size.

(4) **Scale invariance**: This requires that the poverty measure remains unchanged if all incomes, as well as the poverty line, are scaled up or down by the same factor. This approach ensures that the measure is independent of the unit used for measuring income.

The final two properties are dominance properties that require the measure to be consistent with certain basic changes in the distribution.

[26]**Invariant property**: In mathematics, an invariant is a property held by a class of mathematical objects that remains unchanged when transformations of a certain type are applied to the objects. The particular class of objects and type of transformations are usually indicated by the context in which the term is used.

(5) **Monotonicity**: This fifth property is weak monotonicity, which requires poverty to rise or remain unchanged if the income of a poor person falls. In other words, a decrement in a poor person's income can never decrease poverty. Weak monotonicity is a central property of a poverty measure.

(6) **Transfer**: This property considers the effect of a transfer on poverty. A weak transfer property requires poverty to fall or at least remain unchanged in response to a progressive transfer from richer to poorer people or between two poorer people (S. Alkire et al., 2016).

Researchers and policymakers recognize that hunger's wide implications go beyond a country's borders. Analytical tools, such as hunger indices, were designed to comprehensively measure and track hunger through countries, regions, and the world. Such indices are based on different criteria and/or indicators that can be used as powerful tools in assessing the extent of hunger around the world, especially in the hotspots of developing countries. Nevertheless, in order to measure hunger in a more accurate manner, several mathematical indices were also proposed. It was suggested that the hunger index should include a number of technical properties as presented by E. Masset (2011):

(1) **Summarizes:** Hunger indices should summarize information about the phenomenon at hand.

(2) **Sensitive:** Hunger indices should be sensitive to the distribution of outcomes in the population.

(3) **Capture effects**: Hunger indices should capture both short- and long-term effects.

(4) **Reliable data**: Hunger indices should be based on reliable data that covers many countries and is robust to different specifications (E. Masset, 2011).

1.4.2 Inequality measures

The various measures of inequality proposed in the literature fall into two categories: those that make no explicit use of social welfare concepts and those that look at the normative notion of social welfare and the loss caused by unequal distribution. A. Sen agrees with H. Dalton in that an inequality measure should adopt the social welfare concept, and it is with this concept that we should be concerned (A. Sen, 1997). Anthony Atkinson (1970**),** meanwhile**,** found that the conventional approach in empirical work is to adopt statistics in inequality measurement, with no preference for one measurement or another (A. B. Atkinson, 1970; PROVIDE, 2003). An inequality index is a mathematical tool to measure inequality, and some of these are very popular, such as the Gini coefficient (K. Maguire et al., 2011).

Inequality measures are based on the average income, which is derived by considering the distribution of income over *n* households, with the average income, μ, defined as:

$$\mu = \frac{1}{n}\sum_{i=1}^{n} y_i$$

where y_i is the income level for household *i*.

The six important measurements of inequality presented here represent the full spectrum of the commonly used values in this field: (1) the range and the relative mean deviation, (2) the variance and the coefficient of variation, (3) the standard deviation of logarithms, (4) Lorenz curve, (5) Gini coefficient, and (6) Atkinson's inequality measure.

(1) The range and the relative mean deviation: The range (R) indicator of inequality is described by A. Sen (1997, p. 24) as "perhaps the simplest measure" of inequality. This measure divides the difference between the highest and lowest income by the mean income.

$$R = \frac{\mathrm{Max_i} y_i - \mathrm{Min_i} y_i}{\mu}$$

In the case that income is evenly distributed (i.e., that all households earn the same), then R = 0. If one person earns everything, then R = n (the population size). The limitation of R is how it ignores the distribution of income between these two extremes (A. Sen, 1997). The range is calculated for all households as well as subgroups.

An improvement to the range measure is the **relative mean deviation,** which compares the income of each observation with the mean income. The sum of the absolute differences between the income of each household and the sample mean income are then divided by the total income (mean income times number of observations) using the following formula:

$$M = \frac{1}{n\mu}\sum_{i=1}^{n} |y_i - \mu|$$

where y_i is the income level of household *i* and μ is the average income.

If income is perfectly distributed (i.e., all households earn the mean income), then M = 0. When one household earns everything, then M = 2(n −1) /n. A. Sen (1997) points out that this measure violates the Pigou-Dalton principle.

(2) The variance and coefficient of variation: Estimating the variance of a stochastic variable is done by using the deviation from the mean and squaring these differences (Sen, 1997).[27] The

[27] **Stochastic variable**: In probability and statistics, a random variable, random quantity, aleatory variable, or stochastic variable is a variable quantity whose possible values depend on, in a random manner, a set of random outcomes events. https://en.wikipedia.org/wiki/Random_variable

standard deviation is defined as the square root of the variance, and it can be estimated using the following formula:

$$V = \frac{1}{n}\sum_{i=1}^{n}(y_i - \mu)^2$$

Where: y_i is the income level of household i, and μ is the average income.

From an inequality analysis point of view, the attractive feature of the variance or standard deviation is that any transfer from a poorer person to a richer person, ceteris paribus,[28] will increase the variance and hence the inequality, so it satisfies the Pigou-Dalton principle for inequality measures (A. Sen, 1997). On the other hand, however, the variance is not independent of the income scale. In the case that all incomes are doubled, variance quadruples, so it violates the axiom for income-scale independence (J. A. Litchfield, 1999).

(3) The standard deviation of logarithms: The standard deviation of logarithms places a greater importance on the lower income levels. The following formula is used to calculate this inequality measure:

$$H = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\log y_i - \log \mu)^2}$$

where y_i is the income level of household i, and μ is the average income.

The standard deviation of logarithms puts more weight on transfers at the lower income distribution, highlighting differences at the lower end of the income scale (J. A. Litchfield, 1999; A. Sen, 1997).

(4) Lorenz curve: The Lorenz curve is a popular tool to measure inequality in an income distribution. This tool, which was proposed by Lorenz in 1905, shows the proportion of total income that is in the hands of a given percentage of the population. The Lorenz Curve is obtained as follows: The x-axis presents the cumulative proportion of population ranked by income level, so its range is therefore (0, 1). The y-axis, meanwhile, presents the cumulative proportion of income for a given proportion of the population. The income share is calculated as follows:

$$L\left(\frac{k}{p}\right) = \frac{\sum_{i=1}^{k} y_i}{Y} \qquad \text{(range between 0 and 1)}$$

[28] **Ceteris paribus,** or **caeteris paribus,** is a Latin phrase meaning "other things equal." Other English translations of this phrase include "all other things being equal," "other things held constant" and "all else unchanged." A prediction or a statement about a causal, empirical, or logical relation between two states of affairs is *ceteris paribus* if it is acknowledged that the prediction, although usually accurate in expected conditions, can fail or the relation can be abolished by intervening factors. https://en.wikipedia.org/wiki/Ceteris_paribus

where $k=1....n$ is the position of each individual in the income distribution; $i=1....k$ is the position of each individual in the income distribution; P is the total number of individuals in the distribution; Y_i is the income of household i; and $\sum_{i=1}^{k} y_i$ is the cumulated income up to the k^{th} individual. Figure 1 illustrates the shape of a typical Lorenz curve. In the graph, the curve starts from coordinates (0,0), representing how none of the population owns a zero fraction of income. The Lorenz curve records cumulative proportions, so it must hold that (1,1) represents how the entire population combined owns all income. With a perfectly equal income distribution, where every person has the same income, this case is represented by the straight line $y = x$, which is known as the "line of perfect equality." A typical income distribution comprises poor and rich people, however.[29] This leads to a convex curve as depicted in Figure 1. In the Lorenz curve, the more inequality there is in the income distribution, the more convex it will be. The shape of the Lorenz curve is therefore a good visual indicator of the level of inequality in an income distribution. When incomes are less dispersed (i.e., there is less variability among incomes), the Lorenz curve tends toward the equality line (L. G. Bellù, 2006).

(5) The Gini coefficient: The Gini coefficient is most widely used as an inequality index. Its popularity is likely due more to the fact that it is easily understood as an increasing function of the area between a Lorenz curve and the line of perfect equality (K. Maguire et al., 2011). The Gini coefficient can be calculated by dividing the area between the Lorenz curve and the line of perfect equality by the total area underneath the line of perfect equality, as marked in Figure 1 by A and B.

$$\text{Gini Coefficient} = \frac{\text{A}}{\text{A+B}}$$

Technically, this coefficient ranges between zero and one, but in practice, typical values usually range between 0.20 and 0.30 for countries with a lower degree of inequality and between 0.50 and 0.70 for countries with a high degree of inequality (P. Aghion, 1999).

The Gini coefficient and Lorenz curve are useful tools to give a general idea of the extent of the inequality. This geometrical interpretation based on the Lorenz curve is only one of the possible

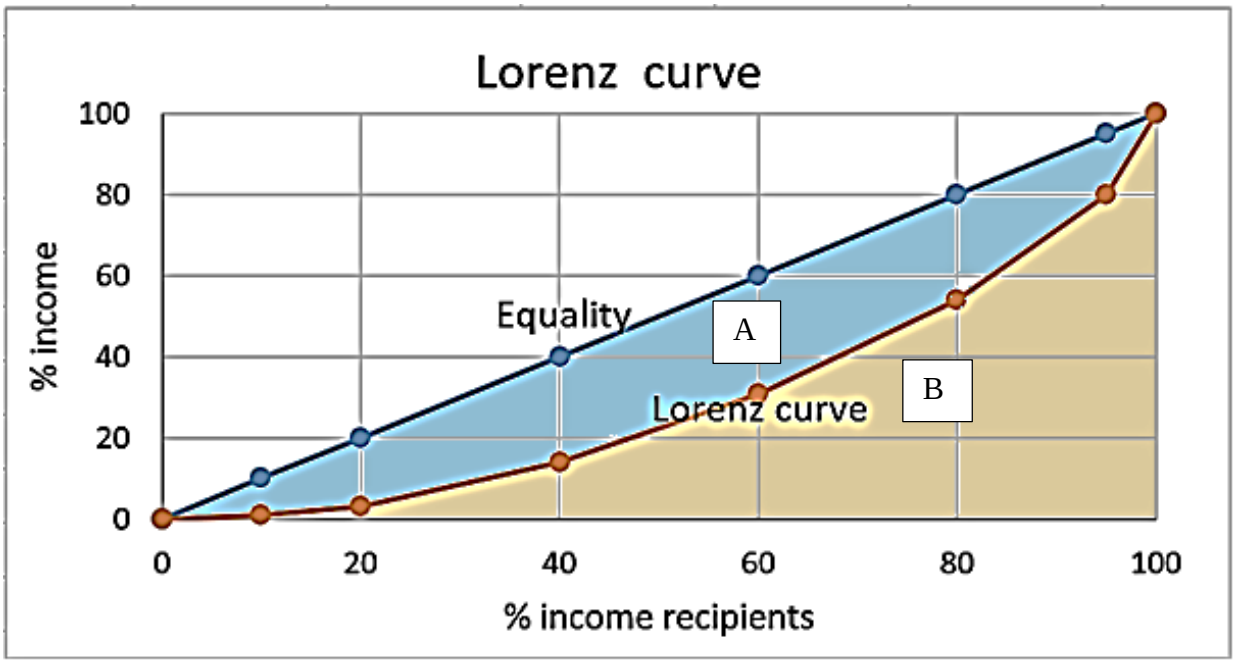
[29] **Income distribution example**: In the case of a very poor, undeveloped country like Namibia, 20% of the population share only 1% of the country's income, while the richest 20% of the population share 79% of the country's income. Namibia has one of the most uneven distributions of income in the world. In Denmark, a developed country, the poorest 20% of the population share 8% of the country's income, while the richest 20% of population share 36% of the country's income.

ways to calculate the Gini index. It is also possible to directly express the Gini Index in terms of the covariance between income levels and the cumulative distribution of income, calculated as follows:

$$G = Cov(y, F(y))\frac{2}{y}$$

where *Cov* is the covariance between income levels *y* and the cumulative distribution of the same income F(*y*), and *y* is average income.

Figure 1: The Lorenz curve and the line of perfect equality



Source: own elaboration

The above Gini index is the standard version that does not allow for any variation in the degree of inequality. A generalized version was proposed by S. Yitzhaki et al. (1989). The Gini index in this considers the specified degree of inequality, with the formula as follows:

$$G(v) = -\frac{v}{y}Cov[y, (1 - F(y))^{v-1}]$$

where all terms have the same meaning as in (8) and *v* is the degree of inequality aversion (L. G. Bellù, 2006).

The Gini coefficient fulfills some of the desirable properties for a measure. For example, if all incomes were doubled, inequality measures are unaffected **(income scale independence)**. Inequality measures are invariant to replications of the population **(principle of population**). The

Gini coefficient also satisfies the desirable properties of **symmetry** and **Pigou-Dalton Transfer**. Unfortunately, the Gini coefficient does not satisfy some desirable criteria, such as **decomposability**. In this case, the Gini coefficient for a specific society is not equal to the sum of its subgroups (World Bank, 2005).

(6) Atkinson's inequality measures: Atkinson's inequality measures also use a weighting parameter Ɛ to represent aversion to inequality. Some of its theoretical properties are similar to those of the extended Gini index, as presented by S. Yitzhaki (1983). The Atkinson inequality is defined as:

$$A_\varepsilon = 1 - \left[\frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\bar{y}}\right)^{1-\varepsilon}\right]^{1/1-\varepsilon}, \varepsilon \neq 1$$

$$A_1 = 1 - \frac{\prod_{i=1}^{N}\left(y_i{}^{(1/N)}\right)}{\bar{y}} \qquad , \varepsilon = 1$$

where: y_i is the incomes and $\bar{y}$ is the mean income.

The inequality aversion parameter ranges from zero to infinity, introducing some flexibility. The higher the parameter's value, the more weight that society places on transfers to individuals with lower outcomes. However, since the choice of this parameter value is entirely normative, it is common to calculate Atkinson indexes for several values to determine how sensitive rankings are to the choice, as shown in Table 1 (K. Maguire et al., 2011). Table 1 presents two different regions (1 and 2) of country A. The first row of numbers gives the incomes of the ten individuals who live in the different regions, while the mean income is 33.

Table 1: Atkinson computing measures of inequality

	Atkinson	Region 1					Region 2				
Incomes (y_i)		10	15	20	25	40	20	30	35	45	90
Mean incomes ($\bar{y}$)= **33**											
($y_i/\bar{y}$) ^0.5 Atkinson Ɛ=0.5	0.087	0.55	0.67	0.78	0.87	1.10	0.78	0.95	1.03	1.17	1.65
(y_i) ^(1/n) Atkinson Ɛ =1	0.164	1.26	1.31	1.35	1.38	1.45	1.35	1.41	1.43	1.46	1.57
($y_i/\bar{y}$) ^ (-1) Atkinson Ɛ =2	0.290	3.30	2.20	1.65	1.32	0.83	1.65	1.10	0.94	0.73	0.37

Source: Own elaboration of Data K. Maguire et al. (2011)

The Atkinson index satisfies several desirable theoretical properties, but on the other hand, it is lacking in other relative indices. For example, it is a function of individual allocations rather than rank (S. C. Kolm, 1976; C. Blackorby et al., 1978). Furthermore, the Atkinson index is generally not defined for negative numbers, and it cannot be calculated for a population containing zero incomes. Even in a case where negative values are defined, the Atkinson index generates the perverse result that a progressive redistribution reduces social welfare (K. Maguire et al., 2011).

The different inequality measures discussed in this subchapter and presented in Table 2 give an idea about how inequality measures are expressed for different populations and regions.

Table 2: A summary of the different inequality measures discussed in this sub chapter

Inequality measure	Urban households	Rural households	African households	Indian households	White households
Mean income	19216.9401	9759.1711	7413.34	24169.07	44702.49
Range	6679.0010	272.3421	74.40	15.20	59.42
Relative mean deviation	0.8507	1.0780	0.8210	0.6952	0.6846
Std. deviation	31639.2802	43302.3322	12503.90	30420.72	75589
Gini coefficient	0.5718	0.6876	0.5462	0.4789	0.4786
Std. deviation logarithms	0.8456	0.9414	0.8270	0.7689	0.7664

Source: own elaboration, Data: IES/OHS,[30] 1995

[30] **OHS**: October Household Survey 1995
IES: Income and Expenditure Survey 1995

1.4.3 Poverty measures

Poverty and inequality are usually referred to as related concepts, yet there is not necessarily a link between the two. In other words, a high incidence of poverty does not necessarily correlate with a high degree of inequality, and vice versa. This is because a desired property of an inequality measure is that it be independent of the income scale. By this logic, inequality can be high even in countries with no poverty (J. A. Litchfield, 1999).

Measuring poverty is an important issue at the macroeconomic level. It is a means of assessing one aspect of the population's economic wellbeing by focusing on its poorest segment, as well as comparing findings across countries or periods. At the microeconomic level, it is an objective target tool for policymakers to identify who makes up the poor (S. Alkire et al., 2016).

When it comes to poverty measurements focused on measuring the incidence and depth of poverty, there are two different approaches. The first to be developed was the income approach. Poverty measurement techniques logically follow from the definition of poverty (S. Bibi, 1998, p. 181), which according to the World Bank is the "inability to attain a minimal standard of living" (A. D. Oduro, 1999, p. 2). For J. Foster et al. (2013, p.19), meanwhile, "At its most general level, poverty is the absence of acceptable choices across a broad range of important life decisions-a severe lack of freedom to be or to do what one wants."

Poverty is mostly defined through poverty lines, which are cutoff points separating the poor from the better off. It is a monetary perspective that refers to a certain level of consumption or literacy. PROVIDE (2003) defines the poverty line as the minimum expenditure required by an individual to fulfill his or her basic food and non-food needs. The World Bank (2005), meanwhile, defines the poverty line as the minimum level of income deemed adequate in a particular country. The poverty line is significantly higher in developed countries with HDI scores under 0.700 than it is in developing countries.[31] Differences in the cost of living around the world mean the global poverty line needs to be periodically updated to reflect these changes. In 2008, the global line was set at $1.25 purchasing-power parity (PPP). In October 2015, the international global line was updated to $1.90 a day. Often we find that the use of multiple poverty lines can help distinguish between different levels of poverty. Determining the poverty line is usually accomplished by finding the total cost for all the essential resources that an average human adult consumes in a year.

[31] **HDI**: We will refer to this subject later.

There are two main approaches to setting poverty lines: relative and absolute. The relative poverty line is defined in relation to the overall distribution of income or consumption in a country. For example, the poverty line could be set at 50% of the country's mean income or consumption. The absolute poverty line, meanwhile, is based on some absolute standard of what households should be able to afford to meet their basic needs. It is often based on estimating the cost of basic food needs, such as the cost of a nutritional food basket that would be considered the minimum for a typical family's health, as well as nonfood needs. The choice of a poverty line is ultimately arbitrary, since it resonates with the social norms of the country, so it varies between rich and poor countries (A. Coudouel et al., 2002).

Scholars present different methods for measuring poverty, and they are designed to capture the many facets of this phenomenon (S. Alkire et al., 2016). The standard approach of measuring poverty in terms of household income has been used since the 1920s. Anyone whose equivalent income falls below the poverty line is poor. This approach is attractive because it is easy to apply, but it does not effectively identify who is poor. Poverty encompasses several different dimensions of individuals' lives, such as education, health, and housing conditions. Therefore, any measurement methodology that only considers one dimension cannot represent the phenomenon as a whole (A. Coudouel et al., 2002).

Various commonly used poverty measures can be classified into two categories: basic poverty measures and advanced poverty measures. Basic poverty measures include (1) the Headcount Index and (2) the Poverty Gap. Among the advanced measures of poverty are (3) the Sen index and Sen-Shorrocks-Thon index (SST), (4) the Watts index, (5) the Multidimensional Poverty Index (MPI), (6) the Human Development Index (HDI), and (7) the Inequality-Adjusted Human Development Index (IHDI).

(1) **Headcount Index:** This is the most widely used measure of poverty. It measures the proportion of the population that can be considered poor, often denoted by P_0. This index formally expressed as:

$$P_0 = \frac{N_p}{N}$$

where Np is the number of poor and N is the total population (or sample). For example, if 60 people are poor in a total population of 300 people, then $P_0 = 60/300 = 0.2 = 20\%$. The headcount index is therefore simple to construct and easy to understand, but it has at least three weaknesses. First, it does not take the intensity of poverty into account.

Looking at Table 3, for example, it is very clear that there is greater poverty in country A than in B, yet the headcount index does not capture this. The headcount index is unsatisfactory because it violates the transfer principle. In other words, the first Dalton axiom insists that transfers from a richer to a poorer person should improve the measure of welfare. Moreover, this index does not change if just the people already below the poverty line become even poorer.

Table 3: Headcount poverty rates in countries A and B

	Expenditure for each individual in country				Headcount poverty rate (P_0)
Expenditure in country A	100	100	150	150	50%
Expenditure in country B	124	124	150	150	50%

Source: Own elaboration

(2) **Poverty gap index:** This popular measure adds up the extent to which individuals on average fall below the poverty line, expressing it as a percentage of the poverty line. The poverty gap (G_i) is defined as the poverty line (z) less actual income (y_i) for poor individuals, while the gap is considered to be zero for everyone else. G_i is defined as:

$$G_i = (Z - y_i),\ I(y_i < Z)$$

The poverty gap index (P_1) may then be written as:

$$P_1 = \frac{1}{N}\sum_{i=1}^{N}\frac{G_i}{Z}$$

Table 4 presents poverty gap index calculation, in which the expenditure for each individual in country A, as well as the poverty line value, are arbitrary numbers. Assuming a poverty line of 125, G_i is divided by the poverty line and averaged to give P_1, the poverty gap index.

Table 4: Poverty gap index

	Expenditure for each individual in country				Poverty gape index (P_i)
Expenditure in country A	100	110	150	160	
Poverty gape	25	15	0	0	
G_i/Z	0.2	0.12	0	0	0.08 [0.32/4]

Source: Own elaboration

The squared poverty gap index takes into account inequality among the poor. It simply weights the sum of the poverty gaps, where the weights are proportionate to the poverty gaps

themselves. For example, in the case of a poverty gap of 10%, the poverty line is given a weight of 10%. Similarly, with a 50% poverty gap, a weight of 50% is used. This contrasts with the poverty gap index where they would be weighted equally. Therefore, by squaring the poverty gap index, the measure implicitly emphasizes observations that fall well below the poverty line. This poverty measure i

s not easy to interpret, however, so it is not used widely. The squared poverty gap (P_2) is formally calculated as follows:

$$P_2 = \frac{1}{N}\sum_{i=1}^{N}(\frac{G_i}{Z})^2$$

Table 5 presents a squared poverty gap index calculation in which the expenditure for each individual in country A, as well the poverty line of 125, are arbitrary numbers.

Table 5: A squared poverty gap index calculation

	Expenditure for each individual in country				Squared Poverty gap index (P_2)
Expenditure in country A	100	110	150	160	
Poverty gap	25	15	0	0	
G_i/Z	0.2	0.12	0	0	
$(G_i/Z)^2$	0.04	0.0144	0	0	[0.0544/4]

Source: Own elaboration

(3) **Sen index:** This index considers three parameters: the number of poor; the depth of their poverty; and the distribution of poverty within the group. The index is given by:

$$\mathrm{P_s} = \mathrm{P_0}(1 - (1 - \mathrm{G^P})\frac{\mu^{\mathrm{P}}}{\mathrm{Z}})$$

where P_0 is the headcount index, μ^P is the mean income of the poor, and G^P is the Gini coefficient of inequality among the poor. The Gini coefficient ranges from 0 (perfect equality) to 1 (perfect inequality). The Sen index is almost never used outside of academic literature, perhaps because it lacks the intuitive appeal of some of the simpler measures of poverty (Deaton, 1997, p.147). The Sen index has been modified by others, however, such as with the Sen Shorrocks-Thon (SST) index, which is defined as:

$$\mathrm{P_{sst}} = \mathrm{P_0}\mathrm{P_1^p}(1 + \widehat{\mathrm{G}}^{\mathrm{P}})$$

This is the product of the headcount index, the poverty gap index (applied to the poor only), and a term with the Gini coefficient of the poverty gap ratios for the whole population. This Gini coefficient typically is close to 1, indicating great inequality in the incidence of poverty gaps (World Bank, 2005).

(4) **Watts index:** This index takes the form:

$$W = \frac{1}{N}\sum_{i=1}^{q}[ln(z) - ln(y_i)]$$

Here, the N individuals in the population are indexed in ascending order of income, and the sum is taken over the q individuals whose income y_i falls below the poverty line z. An example calculation for this index is given in Table 6. It shows the different steps: dividing the poverty line by income, taking logs, and finding the average over the poor. Table 6 then presents a Watts index (W) calculation, where the expenditure for each individual in country A, as well the poverty line value of 125, are arbitrary numbers. The Watts index is an attractive poverty measure because it satisfies all the theoretical properties that one would want in a poverty index. However, this index is not an intuitive measure, so it is rarely seen in practical fieldwork (World Bank Institute, 2005).

Table 6: Watts index for three different cases

	Expenditure for each individual in country				Watts index (W)
Case 1- poor					
Expenditure in country A	100	110	150	160	
Z/y_i	1.25	1.14	0.83	0.78	
$\log(Z/y_i)$	0.223	0.128	-0.182	-0.247	**0.351**
Case 2- less poor					
Expenditure in country A	110	120	150	160	
Z/y_i	1.140	1.040	0.830	0.780	
$\log(Z/y_i)$	0.128	0.041	-0.182	-0.247	**0.169**
Case 3 - deeper poverty					
Expenditure in country A	90	120	150	160	
Z/y_i	1.250	1.100	0.830	0.780	
$\log(Z/y_i)$	0.329	0.041	-0.182	-0.247	**0.369**

Source: Own elaboration

(5) **The Multidimensional Poverty Index (MPI):** This index was first published in 2010 by the Human Develop Report. MPI combines two aspects of poverty: 1) Incidence, which is the

percentage of people who are poor or the headcount ratio (H) and 2) the intensity of people's poverty, which is the average percentage of dimensions in which poor people are deprived (A). The MPI index takes the form:

$$MPI = H \times A_{incidence} \times Intensity$$

This supplements income-based measures of poverty by incorporating other forms of deprivation in the areas of health, education, and standards of living. The measure is based on household survey data, and each person in a household is classified as either poor or non-poor depending on the deprivations his or her household experiences. Multidimensional poverty is defined as having at least 30% of the indicators showing acute deprivation in health, education, and standard of living. According to this measure, more people live in poverty worldwide than other estimates show (S. Alkire, 2016).

(6) **The Human Development Index (HDI):** Different indices for poverty and inequality have already been introduced, but they mostly look at different dimensions separately, such as using income as a measurement of poverty. It implies that the joint distribution of achievements across the population is ignored. The Human Development Index (HDI) is a social index that provides an important yardstick in measuring global poverty by looking at aspects beyond just income. The HDI examines three basic indicative dimensions of human development: health, education, and living standards. It gives each country a score ranging from 0 to 1, with 1 being the highest developed. Health is measured by life expectancy at birth. Since 2010, the HDI has measured education and living standards in new ways. Progress in education is now determined by calculating the mean number of years of schooling for adults ages 25 and older, along with the expected number of years of schooling for school-age children. Income measurement has shifted from per capita gross national product (GDP) to gross national income (GNI). Table 7 presents the wide variations of Human Development Index among countries.

(7) **Inequality-Adjusted Human Development Index** (IHDI): Even though the HDI is a multidimensional indicator, it captures only a portion of what human development entails. In practice, the HDI is an average measure of basic human development achievements in a country. Like any average-based measure, the HDI masks inequality in the distribution of human development across a country's population. In 2010, the Human Development Report (HDR) introduced the Inequality-Adjusted Human Development Index (IHDI), which takes into account any inequality in the three dimensions of the HDI to give a more accurate picture of human

development. The greater the inequality gap in a country, the greater the difference between the IHDI and the HDI. In other words, as inequality in a country increases, its score for human development decreases. There is typically about a 22% loss in HDI due to inequality. The IHDI is basically the HDI with penalties for inequalities, so the "loss" in human development resulting from inequality is represented by the difference between the HDI and the IHDI, so it can be expressed as a percentage.

Table 8 shows the average loss due to inequality for some low- and high-HDI countries. The overall loss for countries with lower HDIs was found to be 32.3%. For example, for Sub-Saharan Africa, it is 32.2%. For the countries with higher HDIs, however, such as Norway, it is just 5.4%. The human inequality coefficient for Liberia is equal to 32.9%, while for low-HDI countries on average it is 32.0%. For Germany, a high-HDI country, the human inequality coefficient is 7%.

Table 7: The wide HDI variations among countries

Country	HDI value	HDI rank	Life expectancy	Expected years of schooling	Mean years of schooling	GNI (PPP US$)
Liberia	0.427	177	61.2	9.9	4.4	683
Central African Republic	0.352	188	51.5	7.1	4.2	587
Guinea	0.424	178	55.5	9.2	2.9	1.369
Sub-Saharan Africa	0.523	---	58.9	9.7	5.4	3.383
Low HDI	0.497	---	59.3	9.3	4.6	2.649

Source: own elaboration based on the Human Development Report (2016)

The HDI is the geometric mean of indices for the three dimensions of health, education, and income. Calculating the HDI is performed in two steps: (1) calculating the HDI dimension index as follows:

$$\text{HDI Dimension index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

Calculation of HDI:

$$HDI = (I_{health} \times I_{education} \times I_{income})^{1/3}$$

Where I is the dimension index (Human Development Reports, 2015).

The IHDI then draws on the Atkinson inequality measures and sets the aversion parameter ε equal to 1. In this case, the inequality measure is $A = 1 - {}^{g}/_{\mu}$, where g is the geometric mean and μ is the arithmetic mean of the distribution. The inequality-adjusted dimension indices are obtained from the HDI dimension indices, I_x, $I_x = (1 - A_x) \times I_x$. The IHDI is then the geometric mean of the three dimension indices adjusted for inequality:

$$IHDI^* = [(I^*_{Health}) \times (I^*_{HEducation}) \times (I^*_{Income})]^{\frac{1}{3}}$$

$$IHDI^* = [(1 - A_{Health}) \times (1 - A_{Education}) \times (1 - A_{Income})]^{1/3}$$

(Human Development Report, 2014).

Table 8: IDHI 2015 for selected countries

Country	IHDI value	Overall loss (%)	Human inequality coefficient (%)	Inequality in life expectancy at birth (%)	Inequality in education (%)	Inequality in income (%)
Liberia	0.284	33.4	32.9	33.1	42.9	22.7
Central African Republic	0.199	43.5	43.1	45.7	34.5	49.2
Guinea	0.257	39.3	39.1	44.6	40.3	32.5
Sub Saharan Africa	0.355	32.2	32.1	34.9	34.0	27.4
Low HDI country	0.337	32.3	32.0	35.1	37.1	23.9
Norway	0.898	5.4	5.4	3.3	2.4	
Australia	0.861	8.2	8.0	4.3	1.9	
Germany	0.859	7.2	7.0	3.7	2.6	

Source: own elaboration, based on the Human Development Report (2016)

Table 9: Overall difference between HDI and IHDI at different human development levels

	HDI	IHDI	Overall loss (%)
Very high human development	0.890	0.780	12.3
High human development	0.735	0.590	19.7
Medium human development	0.614	0.457	25.6
Low human development	0.493	0.332	32.6

Source: Own elaboration, based on Human Development Report (2014)

1.4.4 Hunger measures

Hunger indices are important tools in the elimination of hunger everywhere, but they are particularly useful in the case of developing countries. Different approaches and concepts are used to measure hunger, with some focusing on hunger's consequences and others focusing on its causes. Both the World Health Organization (WHO) and the United Nations International Children's Emergency Fund (UNICEF) use the consequence approach and produce annual data on the physical growth among children in developing countries. There is some criticism for these indices, however, with some pointing to how other consequences—such as morbidity and mortality, poor cognitive development, and poor economic productivity—are neglected. More recently, additional hunger indices have been developed. These indices combine both the causes and the consequences of hunger. The most popular among these is the Global Hunger Index (GHI). A less familiar index is the Hunger FREE Scorecard Index, which was developed by ActionAid (D. Wiesmann, 2006; N. Swati et al., 2009).

Hunger indices express a complex set of phenomenon, and various hunger indices have been offered over the years. Some of these are based on one indicator or dimension, while others are multidimensional, leading to a diverse range of hunger estimations (E. Masset, 2011). Five major hunger indices are summarized below.

(1) World Bank Index: The World Bank Index was developed between 1970 and 1980. This index has a great influence with little applicability (R. Longhurst, 2010). Here, hunger is defined as the lack of energy to conduct an active and healthy life, and it is measured according to the proportion of individuals with an insufficient calorie intake. The method uses food availability data from the FAO, converting it into calorific consumption data, and income-distribution data

from household surveys in order to estimate how energy consumption is distributed among the population. When the consumption level is found to be less than the minimum calorific requirement set by the WHO, it is classified as undernourished. From the policy maker's point of view, this index provides the ability to assess hunger on both nationwide and worldwide scales. However, it does not provide a good basis for targeting, because the data for specific countries are not fully reliable (S. Reutlinger & H. Pellekaan, 1986).

(2) FAO Index: The FAO index was first published in 1987 at the Fifth World Food Survey and again in 1996 at the Sixth World Food Survey (FAO, 1987; FAO, 1996). This index measures hunger in terms of the portion of a country's population with a per capita energy consumption below the standard nutritional requirement. Hunger is defined as the inability to maintain a minimum body weight and perform ordinary work because of energy deficiencies. Here, the measurement of hunger is based on three important parameters: the availability of food per capita, the inequality in energy intake, and the country's specific age/sex energy requirements. However, this index has its flaws. Its food availability indicator is a rather poor predictor of stunting, mortality, and economic productivity. It uses data for food availability that is averaged over a three-year period, and it overlooks the effects of seasonal crises or droughts (P. Svedberg, 2000).

(3) Food Quality Index: The Food Quality Index is an attempt to include diet composition in the measurement of hunger levels. Here, hunger is defined as a lack of access to sufficient good quality food. This index uses two indicators, namely the portion of people whose food consumption is deficient (based on calorie consumption data from household expenditure surveys) and the portion of people whose diet is poor (i.e., a diet is insufficient when a household fails to consume at least one item from a list of seven different food categories). Part of the criticism of this index involves how it implies that neither of these two indicators are sensitive to change when it comes to the distribution of outcomes. Furthermore, this index is unable to scale to worldwide hunger or provide data that can be used to monitor progress in fighting hunger (E. Masset, 2011).

(4) Anthropometric Indicators: The Anthropometric Indicators define hunger as a syndrome resulting from the interaction between poor diet and disease (WHO, 1995). Here, three indices are commonly used in assessing the nutritional status of children under the age of five: weight for age,

length or height for age, and weight for length or height (Bruce, 2003). The methodology implemented consists of measuring the height and weight of children under the age of five and comparing their standardized values against an international reference of normal, healthy children (E. Masset, 2011).

(5) Global Hunger Index: The Global Hunger Index is very popular because it explicitly addresses hunger as a multidimensional phenomenon. Its construction involves the use of three available indicators: the share of the population with insufficient access to food (as provided by the FAO); the portion of children under the age of five who are underweight (as provided by the WHO); and the mortality rates of children under the age of five (as provided by UNICEF). The percentage values for these three dimensions are then summed and divided by three. These results are then used to rank developing countries in three categories based on arbitrarily selected cut-off points: serious problem, alarming, and extremely alarming (E. Masset, 2011).

In some cases, hunger estimations with different indices correlate well with each other, such as the FAO, GHI, and ActionAid indices. At times, though, indices correlate rather poorly, as can be seen with the Anthropometric Indices (underweight and stunting) presented in Table 10. Table 11 compares the FAO's hunger index and the anthropometrics indices of underweight and stunting. Stunting is often found to be double the FAO index, although the underweight index shows less divergence. Table 12, meanwhile, presents different country rankings by four hunger indices. In most cases, the differences are puzzling, like in the cases of Ethiopia and India (E. Masset, 2011).

Table 10: Rank correlation between different indices

Rank correlation coefficients between different indices					
	FAO index	Global Hunger Index	Action Aid Index	Underweight	Stunting
FAO index	1.00				
Global Hunger Index	0.98	1.00			
Action Aid Index	0.68	0.78	1.00		
Underweight	0.38	0.59	0.58	1.00	
Stunting	0.44	0.61	0.44	0.6	1.00

Source: own elaboration

Table 11: Extent (%) of hunger in the world

Country	FAO Index 2008	Underweight UNICEF 2009	Stunting UNICEF 2009
Developing countries	16	26	32
Latin America and Caribbean	8	7	16
South Asia	23	42	46
Sub Saharan Africa	30	28	38

Source: own elaboration

Table 12: Country rankings by different indices

Country	FAO Index 2014	Global Hunger Index 2014	Underweight 2014	Stunting 2007-2011
China	42	5	109	4
Ethiopia	89	70	17	7
Guatemala	71	40	57	25
India	69	55	2	1
Malawi	94	32	55	21

Source: own elaboration

Hunger indices have improved our understanding of hunger and proved to be a useful tool in tracking progress in the fight against hunger. However, they are not perfect tools because they lack sensitivity to occurrences like shocks and droughts. The multidimensional indicators are particularly welcomed, because hunger is a multifaceted phenomenon. A very reliable hunger level is obtained by collecting measurements for anthropometric data on stunted children. This simple process is very easy to perform on a large scale with the use of limited technology (P. Svedberg, 2000).

1.5 The regional development and public choice theories

The *regional development* and *public choice* theories are two relevant economic theories for this study's discussion because they link governmental institutions with how they make decisions and pursue development.

The regional development theory emerged from traditional theories such as the neoclassical trade theory and growth theory (C. Dawkins, 2003). Public choice theory, meanwhile, is an approach to political science based on common models in economics and employment. It was made famous by James Buchanan and Gordon Tullock in 1962.

Regional development theory is rooted in elements of classical and neoclassical economic thinking. This theory highlights two aspects: development and region. The objective of development is to raise people's living standards and give them the opportunity to build up their potential. Development occurs in different socioeconomic environments and takes different forms at both national and regional levels. These two factors are influenced by various factors, such as a region's specific history and socioeconomic situation, which in turn results in different levels of regional and national development, whether it be social or economic in nature (M. Sankaran, 2015).

According to R. Capello (2011), regional development theories put the national growth rate as the sum of the individual growth rates achieved by different regions. Thus, national economic development could increase just because of growth achieved by one particular territorial area. Regional development therefore depends on the efficiency of a particular territorial organization's production rather than the availability of economic resources or their efficient spatial allocation (R. Capello, 2011).

Regional development theories point to differences in economic, social, and political performances from region to region. When performance is unsatisfactory, intervention is required at the regional and community level rather than merely at the macro and micro levels. It is therefore necessary to design and formulate policies for each individual region in order to ensure good performance at the national level (B. H. D. J. Savoie, 2017). In other words, regional theories support the actions of institutions and various other bodies in promoting development at a regional level (D. Antonescu, 2014). Such insights and understanding support this study's basic concept of tailoring hunger solutions to a specific country's level of development to ensure improvements in various indicators.

Moreover, in regional development theories, development refers to change in a desirable direction and at an appropriate pace, with this direction and rate of change depending upon the goals and objectives of the proposed development (B. H. D. J. Savoie, 2017). This theory can therefore explain various observed tendencies presented in the research literature. More specifically, it explains why countries with broader development goals and objectives demonstrate better performances. The regional development theory indicates that development presupposes that policy interventions, both direct and indirect, are important in order to achieve the given goals and objectives. It emphasizes the importance of institutions and other bodies in promoting development at a regional level (D. Antonescu, 2014).

Public choice theory was developed in the 1970s based on neoclassical economics applied to the public sector. In the early 1960s, Gordon Tullock and James M. Buchanan, introduced the public choice model as a more effective paradigm for analyzing public policy. According to D.C. Mueller (1989, p.1), "public choice can be defined as the economic theory of nonmarket decision making, or simply the application of economics to political science." The methodology behind public choice resembles that of economics, and the basic behavioral assumption of public choice, as is the case for economics, is that a human is an egoistic, rational, utility maximizer (J. M. M. Weber, 2008).

Promoting development, whether in an economic or social aspect, depends on whether political decisions deliver outcomes that concur with the preferences of the general public. In this field of interest, public choice theory highlights the ways in which governmental institutions make decisions that subsequently affect the economic and social achievements of a country. This theory recognizes that politicians are often motivated by self-interests, so they sometimes do not target the real needs of a country and its people (F. Eryilmaz, 2015). Public choice theory therefore explains the functioning of a government and highlights how its failures are associated with a lack of economic efficiency, specifically when it comes to economic decisions and unfair income distribution. For example, poor economic efficiency is often seen to result from government corruption in developing countries, and this influences such countries' economic and social performances (J. M. M. Weber, 2008).

Conclusions

The discussion presented above leads to the following partial conclusions. Various views of poverty have been adopted by different economic schools of thought, each making an important contribution to the understanding of poverty. The definitions of poverty that have been adopted over time reflect a shift in thinking from a focus on monetary aspects to wider issues like social exclusion:

- **Classical economics** contends that individuals are ultimately responsible for poverty and therefore provide justification for laissez faire policies.
- In contrast, **Neoclassical** (mainstream) economics is more diverse and can provide explanations for poverty, such as market failures, that are beyond individuals' control. Both schools, however, focus on the role of incentives and individual productivity in generating poverty and overemphasize monetary aspects, and they only allow a limited role for government.
- The **Keynesian/Neoliberal schools**, in contrast, focus on macroeconomic forces and emphasize the key role of government in providing not just economic stabilization but also the public good. Poverty is considered largely involuntary and mainly caused by unemployment.
- The **Marxian/Radical views** see class and group discrimination as central to poverty. These theories assign a central role to the state in the intervention and regulation of markets.

Economic theories focus mainly on the relation between inequality and growth, with no consensuses being found about such relations. Two prominent relations that are presented in the literature are that inequality benefits economic growth and that inequality adversely affects economic growth. For example, in the classical approach, inequality is thought to be beneficial for economic development. The neoclassical approach, meanwhile, emphasizes the competitive markets for fixed skills, and under such circumstances, equally productive workers will receive the same wage. For its part, the modern perspective highlights the potential adverse effects of inequality on growth. The unified theory, meanwhile, claims that human capital accumulation is the prime engine of economic growth.

Gross inequality and extreme poverty abound in market economies, showing the limits of what market systems alone can achieve to guarantee distributive justice. Efficiency, distribution, and liberalization are recognized as being important to market systems, and these market issues are treated by the three Welfare Theorems of Economics. These theorems concern the relationship

between market equilibrium and Pareto efficiency, but the theorems are only true under certain conditions. The welfare theorems preserve distribution, because markets themselves would not choose the distribution of wealth and income. They also point out that market allocations will not produce outcomes that are optimal for all distributions. Moreover, that markets are powerful tools, but only when the distribution is reasonable and there is no case for market allocation in the absence of a good distribution.

Welfare theorems are also relevant to market intervention**.** The Second Welfare Theorem considers that non-market intervention will generally be needed in order to achieve any desired Pareto optimal allocation. However, market outcome is not always as efficient as it should be. When the market does not work due to market failures, government intervention is justified to encourage a more efficient and equitable use of resources. Intervention in credit markets is well founded, and in principle, this type of intervention is both equity and efficiency enhancing.

The economic approach links four phenomena (poverty, hunger, welfare, and inequality), leading to the development of measurement tools. Sustainable development has a direct relation to poverty and welfare. An operational implication of this concept is the economist view that focuses on methods to maximize human welfare, as well as address poverty reduction by integrating sustainable development into the development agenda. Poverty reduction, in the context of sustainable development, requires economic growth and investment in people, processes that are mutually reinforcing. The FNS perspective to address food security is a food system approach that requires social and ecological concepts to address a complex array of hunger problems. Poverty and inequality are directly and indirectly linked to hunger through their link with economic growth. Poverty, inequality, and growth also interact with one another through a set of bidirectional links. Inequality, meanwhile, can indirectly influence poverty, because inequality affects growth, while growth in turn influences poverty, so minor changes in income distribution can have a considerable effect on poverty.

Measures of inequality, poverty, and hunger can influence our understanding, and analyzing each of these phenomena also serves different policy purposes. These measures usually seek to conform to a certain set of axioms that are actually desirable mathematical properties, such as decomposability and symmetry. Although some poverty and inequality measures do not satisfy some of these desirable properties, they can still act as good measuring tools to serve different policy purposes. Inequality measures are mathematical tools, and the most widely used indices

are generally the ones that are easily understood. Some are interpreted visually, such as the Lorenz curve and Gini coefficient.

Different methods for measuring poverty have been designed to represent the many facets of this phenomenon, as well as the standard approach based on the poverty line. Poverty affects several different dimensions of individuals' lives, so a measuring methodology that considers only one dimension cannot apprehend the phenomenon as a whole. Hunger measures present different approaches and concepts, with some focusing on hunger's consequences and others focusing on its causes. Such a focus leads to other consequences being neglected, however. Thus, in some cases, while some hunger estimations from different indices correlate well with each other, others may correlate rather poorly. Hunger indices are by no means a perfect tool, since they are not sensitive to events like shocks and droughts. The multidimensional indicators are particularly welcomed because of the multifaceted nature of the hunger phenomenon. A very reliable hunger level can be obtained through the collection of data based on anthropometric measurements, such as the incidence of stunting in children.

Chapter 2: The problem of hunger and food and nutrition security in developing countries

2.1 Hunger in the modern world

2.1.1 Scope of the hunger problem

The history of humanity is riddled with hunger and famine. Pretty much every civilization that has ever existed has been affected by hunger or famine at times.[32] Going as far back as biblical times, the Book of Genesis tells of a severe famine afflicting the land of Canaan and forcing Abraham to move to Egypt. In many cases, hunger appears to correlate with disruptions in the food supply caused by war or adverse weather. Some well-known famines of the late 20th century include the Biafra famine of the 1960s, the Khmer Rouge in Cambodia in the 1970s, the North Korean famine of the 1990s, and the Ethiopian famine of 1984. By the 21st century, however, hunger became more prevalent in the developing world (S. Devereux, 2001).

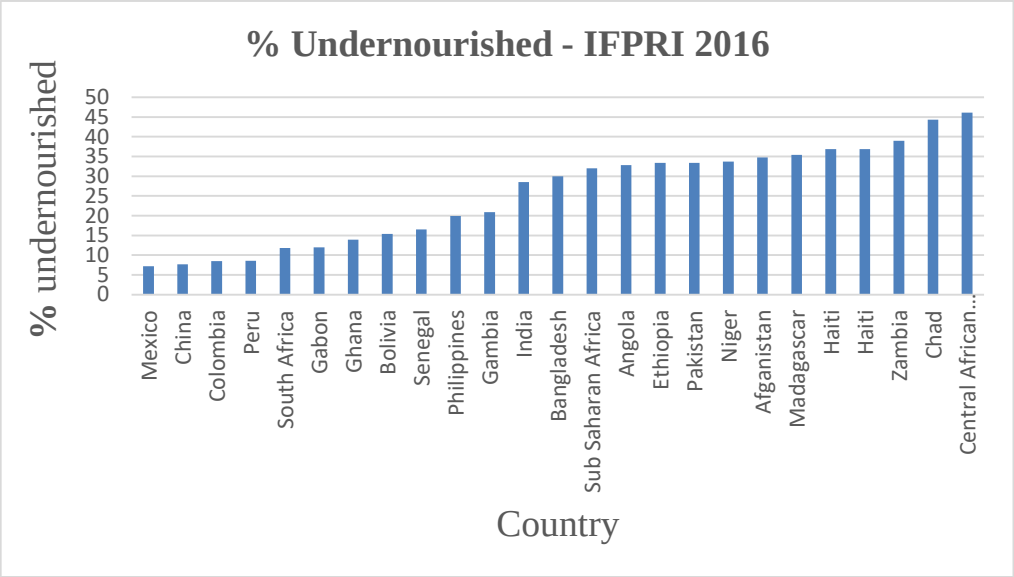
Hunger and poverty are very familiar to many people, particularly those in the developing world. Rather than being a fleeting event, it is a phenomenon that has done permanent damage. When hunger, or the lack of food, persists, the consequences can be devastating. Most information about the state of hunger in the world comes from various large organizations, such as the Food and Agriculture Organization (FAO), as well as governments that also work to eradicate this phenomenon. The FAO (2015) estimates that between 2014 and 2016, approximately 795 million people of the world's 7.3 billion population, one in nine people, suffered from chronic undernourishment.[33] Of those 795 million people, 780 million live in developing countries (FAO, 2015). The International Food Policy Research Institute (IFPRI, 2015) report points out that in 2015, the number of undernourished people worldwide was estimated at 854 million, with 820 million living in developing countries. One of the highest regional concentrations of

[32]**Hunger and famine are different problems**. Hunger is chronic undernourishment. The hungry of the world have sufficient food to survive but not enough for good health on a continuing basis… Famine, meanwhile, is a different problem. Persons afflicted by famine do not even have enough food to survive. If they do not obtain food somehow, they will inevitably die. The fundamental difference between famine and hunger therefore lies in whether the people have enough food to survive or not.
https://hungermath.wordpress.com/2012/10/06/the-difference-between-hunger-and-famine/

[33]**Undernourishment and Hunger:** Undernourishment is "a state, lasting for at least one year, of inability to acquire enough food, defined as a level of food intake insufficient to meet dietary energy requirements." In the FAO report, "hunger" is synonymous with "chronic undernourishment."
https://ourworldindata.org/hunger-and-undernourishment/

undernourishment is in South Asia. According to the Global Hunger Index (GHI) scores for 2016,[34] hunger levels were highest in the Central African Republic with 46.1%. Following that was Chad with 44.3% and Zambia with 39%. Other countries are presented in Figure 2 (IFPRI, 2016).

Figure 2: The proportion of undernourished people in different countries



Source: own elaboration, Data: IFPRI, 2016

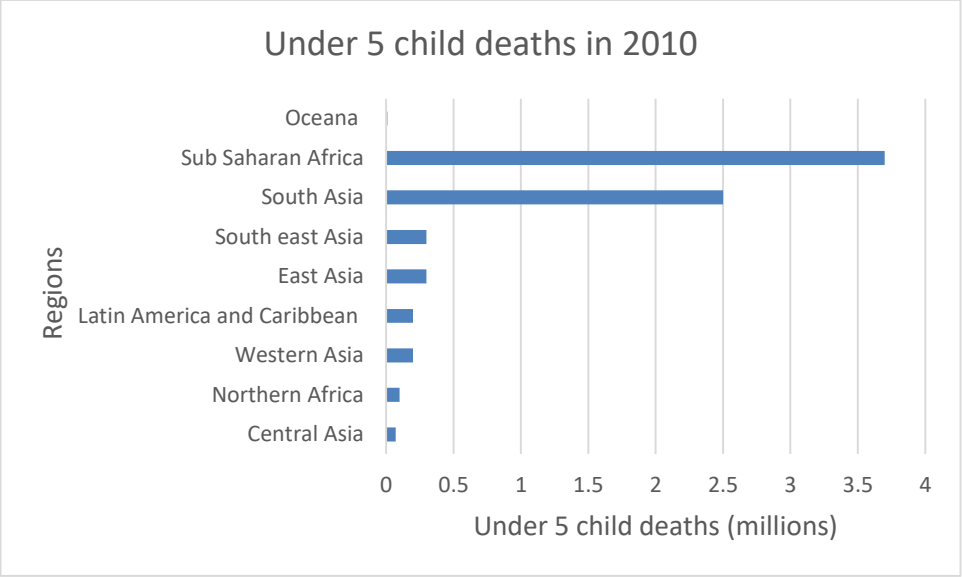
Children are the most visible victims of malnutrition. Of the 7.6 million child deaths (under 5 years old) in 2010, the vast majority occurred in just two regions: South Asia and Sub-Saharan Africa (Figure 3). R.E. Black et al. (2013) estimate that malnutrition is the cause of 3.1 million deaths among children annually, some 45% of all child deaths in 2011. R.E. Black et al. (2003) point out that malnutrition intensifies the effect of all diseases, including measles and malaria. The estimated proportions of deaths where malnutrition is an underlying cause are roughly similar to diarrhea (61%), malaria (57%), pneumonia (52%), and measles (45%) (R.E. Black et al., 2003).

[34] **GHI** scores will be discussed later.

The urgent need to eliminate the hunger problem is quite clear, even without knowing the method, just based on moral issues. In a world of plenty, the number of human beings dying or suffering from hunger, malnutrition, and hunger-related diseases is staggering. Some ethicists claim that it is our moral duty to always act in ways that will maximize human happiness and minimize human suffering (A. Claire et al., 2015).

Many researchers have worked toward the reduction of the hunger dimension. It was therefore realized that there was a need to define this concept, along with other related terms such as food security and nutrition security, in order to have an objective perspective on the matter when reducing hunger. There is a wide range of concerns related to hunger, because it is a multidimensional phenomenon. However, our interest in hunger is limited to the following three important aspects: (a) hunger's definition, (b) hunger indices, and (c) hunger's scope and consequences.

Figure 3: The number of child deaths in various regions



Source: own elaboration, Data: UNICEF (2011)

2.1.2 Socioeconomic profile of countries with hunger problems

One of the most important reports came from the FAO. The FAO (2002) indicated that 800 million people were suffering from chronic hunger in developing countries. It went on to predict that by 2009, another 100 million people would become trapped in the cycle of hunger, mostly in developing countries. The FAO identified Ethiopia as suffering more than any other country from starvation. Statistical evaluations from the FAO in 2010 described an increase in the number of hungry people, leading to a total of 842 million. In other words, approximately 13.1% of the world's population is in a state of hunger, while about half of the children born to famine-stricken areas die every year (FAO 2010; FAO, 2009; FAO, 2002).

The U.S. Department of Agriculture (USDA) observed similar results. It predicted that by 2017, the number of hungry people worldwide would reach approximately 1.2 billion, a 50% increase since 2006. This was a stark and terrifying trend, and as the British magazine *The Economist* argued, if the hunger crisis is not addressed, a "mass starvation" will result.

The head of the International Monetary Fund (IMF) has indicated that if a 1% increase in food prices occurred, 16 million people worldwide would be shifted into poverty and hunger (FAO, 2013; N. Danon, 2011). The extent and severity of the hunger problem emphasizes the importance of examining the socio economic profile of developing countries.

The socioeconomic profile presents different factors that are essential to a better understanding of the hunger problem. A recognition of these factors could help clarify its present situation, and this could be used as a unique tool when making relevant decisions. Three countries of a similar nature were selected as representatives: Ethiopia from Africa, India from Asia, and Haiti from Latin America. These three countries are typified by severe hunger problems, as can be clearly seen in the high values for each of the four component indicators for the GHI index.[35] Among these indicators is the percentage of the population that is undernourished. According to GHI data (2016), the GHI score for Ethiopia is 33.4, with 32% of its population being undernourished. India's GHI score is 28.8, with 15% of its population being undernourished, while Haiti scores 36.9, with 53.4% of its population being undernourished.

[35] The **Global Hunger Index** has four indicators: the percentage of the population that is undernourished; the percentage of children under five years old who suffer from wasting (low weight for height); the percentage of children under five years old who suffer from stunting (low height for age); and the percentage of children who die before the age of five (child mortality).

Six typical profile characteristics for developing countries were presented covering the following six factors: (1) accelerated natural growth and constant threats to food security, (2) serious crop failures and hunger crises, (3) poor rural households, (4) high GHI indices,[36] (5) an unstable economy, and (6) internal and external challenges.

1) Accelerated natural growth and constant threats to food security: Ethiopia's natural growth is fifth in the world and estimated at 2–3% annually. It is considered a "hotspot," with rapid population growth being accompanied by frequent droughts caused by climate change. This presents serious and ongoing threats to the population's food security. One in ten Ethiopians are in a state of chronic food insecurity. This figure worsened during the time of the droughts, with one in five being subjected to starvation (M. Laurie, 2012). India's natural growth rate is 1.38%, among the highest in the world. According to the UN World Food Program (WFP, 2015) report, 27% of the global population suffering from malnutrition live in India. Of that, 43% are children under the age of five, and they are underweight as well. This is a very high figure when compared to the global average of 25% (India, Wikipedia; P. Chowdhury, 2009). Haiti, meanwhile, with its 9.9 million inhabitants, is not just one of the poorest countries in the Americas region—it is one of the poorest countries in the world. Poverty, food insecurity, and hunger are common threats to its residents. It has experienced a rapid population growth of 1.9% annually since 1960. Haiti's food crisis is very severe, and according to the FAO (2013), there are more than 3.8 million people suffering from hunger there (IFAD, 2013).

2) Serious crop failures and hunger crises: Ethiopia is a country that frequently suffers from extreme weather conditions. In 2008, a very severe drought caused crop failure and 4.6 million people went hungry, while 5.7 million people required emergency assistance in drought areas (J. Barney, 2008). India is a country that suffers from drought due to the low rainfall during the monsoon season, so it is also prone to crop failure and famine crises. According to the Indian agriculture minister, 2009 was a very bad year. A weak monsoon resulted in many provinces suffering from severe drought. Of the 626 provinces, 161 were declared to be in drought. Haiti is another country severely affected by climate problems, and such events often destroy most of its crops. The hurricanes between 2010 and 2012 destroyed most of the country's crops, making 98%

[36] The GHI scores on a 100-point scale, where 0 is the best score (no hunger) and 100 the worst. In practice, neither of these extremes is reached.

of the country's population victims of food insecurity. The UN reported that 1.5 million Haitians, mostly farmers, are at risk of severe malnutrition (H. Locke, 2013).

3) Poor rural households: The wellbeing of the rural populations in these countries is very low and characterized by poverty. Ethiopia comprises 80 million people, most of which live in villages and are mainly reliant on agriculture. The crops are adjusted to the country's annual rainfall patterns, and more than 95% of the land is cultivated this way. Such dependencies cause many rural households to fall into poverty and hunger (M. Laurie, 2012). In addition, Ethiopian farmers suffer greatly from the low productivity of their lands. In some areas, the land has been irreversibly damaged, resulting in a substantial threat to both their livelihoods and their incomes (J. Barney, 2008). In India, about 75% of the population lives in rural areas. Most of the country's wells (about 95%) are used by small farmers and have dried up because of overpumping. This has led to a significant reduction in the volume of grain and threatened the income and nutritional security of the people (L.R. Brown, 2012; IFPRI, 2013). In Haiti, most of the population lives in rural areas, making agriculture a major and important aspect of the country's economy. Haiti's agriculture has been vigorously affected by extreme climate problems, which have at times destroyed most of the crops and caused many rural communities to experience hunger (IFAD, 2013).

4) High GHI indices: High values in the GHI index indicate severe hunger. The GHI score is based on three indicators: (a) the percentage of the population who suffer from malnutrition, (b) the percentage of children under the age of five who are underweight, and (c) the mortality rate of children under the age of five. When examining these three parameters for these countries, we see quite similar situations. In 2012, the Planning Commission and the International Food Policy Research Institute (IFPRI) reported that in Ethiopia, 34.6% of the children under the age of five suffer from malnutrition (J.M. Katju, 2012). Dwarfism, too, is an important indicator of poor diet. Data published in 2012 for World Malnutrition Rates (WMR) showed that in Ethiopia, over half of the children under the age of five were considered to be at the same developmental category as that of a dwarf and therefore at risk of suffering irreversible developmental damage. India, however, contains the highest number of children under the age of five that are underweight (40%). The National Family Health Survey (NFHS) indicates that there is a large variation in the malnutrition levels of the different states of India, sometimes even double. For example, in the state of Madhya Pradesh, 60% of children under the age of five suffer from malnutrition, compared to 24.9% in the state of Punjab (K. Tirath, 2013; P. Ramchandran, 2006; IFPRI, 2013). In 2010, the

GHI indicators for Haiti showed a large gap when compared to its neighboring Caribbean countries. In 2013, there were more than 20,000 deaths of children under the age of five. The child mortality rate in Haiti in 2013 was 73 per thousand, while other Caribbean countries had an average mortality rate of 15 (L.D. Jacobs et al., 2016).[37]

5) Unstable Economy: Ethiopia has had a permanent budget deficit since 1990. International organizations are therefore forced to cover these deficits and provide grants and loans to ensure the country's continued existence. The country is dependent upon this external help to avoid collapse. In January 2014, its government appealed for humanitarian help to feed 2.7 million Ethiopians. The government also asked various organizations, like the World Food Program (WFP), for food distribution to 6.5 million people in a particularly vulnerable situation, such as children, farmers, people with AIDS, the mothers of infants, and refugees (WFP, 2014). In the case of Haiti, this country has never overcome the legacy of colonialism and its consequences. Haiti is subject to a bad economy combined with political unrest and a poor social situation. This country is unable to cope with the sharp increase in food prices. In addition, natural disasters frequently occur, making the situation much worse because of the very big losses to the agricultural sector, about 200 million dollars. Over 2000–2010, the economic growth was about 7.8%, while the Dominican Republic experienced growth of about 35% over the same period (K. Klarreich, 2008; IFAD, 2013).

India is an exceptional case among the developing countries. The Indian economy is the sixth largest in the world in terms of GDP (World Bank, 2015). Over the last two decades, this developing economy has experienced an average growth rate of approximately 7%. However, political corruption has had a negative effect on governmental efficiency and economic performance. In the absence of a well-functioning legal and regulatory framework, corruption remains a serious problem.

6) Internal and External Challenges: In Ethiopia, the government's economic decisions have led to most Ethiopians living in abject poverty with a per capita income that is among the lowest in the world. The Ethiopian government also does not concern itself with the farmers by providing them with arable land but rather pursues an aggressive goal of "land grabbing."[38] Human

[37] For example, the child mortality rate in Jamaica is 2.2, while in the Dominican Republic is it 4.1.

[38] **Land grabbing** is the contentious issue of large-scale land acquisitions, where large pieces of land are bought or leased by domestic and transnational companies, governments, and individuals. https://en.wikipedia.org/wiki/Land_grabbing

Rights Watch said that since 2008, the Ethiopian government has leased and/or sold nearly 10 million acres of prime agricultural land to investors from China, India, Saudi Arabia, and other places, leaving its local farmers with unproductive land that cannot provide for their needs (M. Laurie, 2012). The Ethiopian government also faces external challenges, not just in terms of keeping its borders peaceful but also the numerous refugees fleeing from southern Sudan. By the end of 2014, more than 150,000 Sudanese refugees had fled to Ethiopia, with another 400,000 refugees entering the country from Somalia and Eritrea. This causes social tension between the refugees and the local poor population (WFP, 2014; J. Barney, 2008). Haiti is characterized by its unstable political situation and the serious corruption of its government. This leads to social tensions, and disturbances bring a military regime that is corrupt and brutal. Years of military intervention by the United States have weakened this country, leading to repression and economic stagnation and preventing any recover (K. Picariello, 1997). Terrorism in India poses a significant threat to the people of this country. Terrorism in India includes ethno-nationalist terrorism, religious terrorism, and other terror groups. The regions with long-term terrorist activity include Jammu and Kashmir. In August 2008, the National Security Advisor said there were as many as 800 terrorist cells operating in the country. As of 2013, 205 of the country's 608 districts were affected by terrorist activity.

Profile indicators therefore imply that there are common socioeconomic and political situations in developing countries. These make the population more vulnerable to hunger and poverty than people in developed countries are. Although hunger in developing countries is portrayed as a local problem, as will be clarified later, this issue is definitely having a wider influence. As one Haitian trafficker said, some people can no longer suffer from hunger. There are warnings that if this subgroup becomes the majority, this country, which is the poorest in the region, could become very violent (K. Klarreich, 2008). In addition, the FAO Director-General Diouf said that the "silent hunger" crisis threatens stability and peace in the world (FAO, 2009).

2.1.3 Hunger and inequality

Inequality has increased within countries and between countries, particularly within developing countries (M. Ravallion, 2013). L. Granoff et al. (2015) point out that the average economic growth rate does not translate directly into income growth for poor people. The rate of growth for these poor people is generally lower than the national average. To explain their theory,

the authors use a popular metaphor: “a rising tide may lift all boats, but anyone who knows about tides knows that they rise to different heights in different places” (L. Granoff et al., 2015, p.18).

Hunger, beyond being an unacceptable social phenomenon, hints at the existence of inequality. Actually, inequality is a depiction of not being equal, especially in terms of status, rights, and opportunities. It is found to exist both within and between countries. In general, inequality is always a relative term referring to differences between levels of living standards, incomes, and so on. Economic inequality refers to how economic variables are distributed among the individuals in a group, among the groups in a population, or among countries. Inequality’s two perspectives include the inequality of opportunities, such as unequal access to employment or education, and the inequality of outcomes in various material dimensions of human wellbeing, such as level of income, educational attainment, health status, and so on (H. Afonso, 2015). One of the most striking examples of unequal resource distribution is given by the existence of chronic hunger in some parts of the world, especially that of children, with there being as many as 150 million malnourished children.

In January 2011, global food prices reached their highest point. According to the FAO (2011), the price hike was another indication of unequal resource distribution in the world. People in rich countries were not subjected to hunger during the food crisis, because they only spend a modest portion of their income on food. In contrast, families in poor developing countries can spend up to 80% of their incomes on food. Such spending leads to hunger on a local level and seriously impacts global prices (Humanium, 2015).

The gap between the rich and the poor within countries is paralleled by the gaps between countries. Since countries differ vastly in population size, a common way to compare countries is by the GDP per capita. Such comparisons show considerable differences between countries. The highest values are found in the rich countries that lead as capitalist nations. Such countries were first to industrialize, and they have a history of colonization in Latin America, Africa, and Southeast Asia. The rich countries—such as the United States, Japan, and Germany—have a per capita GDP of 20, more than 100 times more than poor countries like Ethiopia, Malawi, Afghanistan, and Bolivia. The richest countries are the ones where capitalism first emerged, while poorest countries have a long history of colonial and imperial domination. In terms of per capita GDP, none of the countries in Latin America rank in the top 35, while none of the African countries rank in the top

55. More than a half of the world's poorest 50 countries are found in Africa, while 60% of the top 50 are found in either North America or Europe (M.D. Yates, 2004).

There has been a significant growth in inequality between countries in the globalization phase following 1980. For example, while Asia has experienced rapid growth, countries in Africa and Latin America have grown very slowly, if at all. In the globalization years, rich developed countries have pulled away from other countries, causing greater inequality with developing countries. Before this period, the differences between countries were less marked. Rapid growth in large developing countries like India and China helps to close the gap with middle-income countries like Mexico and Brazil but not with very rich countries like those in North America or Japan. M. Luke (2010) argues that much of the equalization is due to the rapid growth in China and to some extent India. As a result of the benefits of China's growth being unevenly distributed, the country has experienced marked inequalities that can easily be identified. For example, while the east coast urban areas are getting richer, the other rural areas are falling behind.

Therefore, the richest countries and peoples have pulled away from the poorest countries and peoples. According to the United Nations Development Program (UNDP 2003), the top 25 million richest Americans have a combined income equal to that of nearly 2 billion of the world's poorest. M. Muiu, and G. Martin (2009) found that many of the inequalities factors—such as wealth, income, health, and education—become worse rather than better over time. In 1820, Western Europe's per capita income was 2.9 times that of Africa, but in 1992, it was 13.2 times more (M. Luke, 2010). D. Hardoon (2017) reports that since 2015, the richest 1% has come to hold more wealth than the rest of the planet. What is more, between 1988 and 2011, the incomes of the poorest 10% increased by just $65 per person, while the incomes of the richest 1% grew by $11,800 per person, some 182 times more.

B. Milanovic (2002) divides the world's income inequality into two groups of countries: those that have 13% of the world's population with 45% of the world's PPP income and those that have 42% of the world's population but receive only 9% of the world's PPP income. The first group comprises the following seven countries: The United States, Japan, Germany, the United Kingdom, France, Australia, and Canada. This includes more than 500 million people with an annual income level over 11,500 PPP$. The second group, meanwhile, comprises India, Indonesia, and rural China. It includes 2.1 billion people whose income level is under 1,000 PPP$. Table 13 shows the mean regional GDP per capita (US$) and GDP per capita (PPP$) for different groups of

countries. In 1960, the ratio between North America and the poorest Sub-Saharan Africa region was 22 to 1 using GDP per capita in current dollars and 14.4 to 1 using GDP per capita in PPP$. In 2015, the ratio between these two regions was 34.4 to 1 using GDP per capita in current dollars and 14.8 to 1 using GDP per capita in PPP$. This gap clearly gets wider over the years, especially for developing countries.

Table 13: Mean regional GDP per capita (US$) and GDP per capita (PPP $)

	GDP per capita (US$)1960	GDP per capita (US$) 2015	GDP per capita (PPP$) 1990	GDP per capita (PPP$) 2015
World	450	10112	5422	15691
OECD members	1358	30095	16627	40589
South Asia	83	1538	1203	5664
Sub Saharan Africa	132	1594	1641	3711
North America	2942	54837	23569	54926
Latin America & Caribbean	368	8450	5726	14956

Source: own elaboration, Data World Bank

In general, economic inequality often closely matches a lognormal distribution or Pareto distribution.[39] Different tools are used to measure economic inequality, while the Gini Coefficient is very commonly used.[40] Rather than simply comparing different income groups with in a society, the Gini coefficient measures a society's inequality as a whole. The Gini coefficient is equal to 1 if all income goes to a single person while everyone else gets nothing, so the maximum inequality is reached, the lower the Gini value is, the more equal a society is. According to the OECD Factbook report (2011), most OECD countries have a Gini coefficient lower than 0.32 and greater than 0.24. Unequal societies include the UK with a score of 0.34 and the USA with a more unequal society scoring 0.38. On the other hand, Denmark is a much more equal society that scores 0.25.

[39] **Log-normal distribution:** In probability theory, a **log-normal (or lognormal) distribution** is a continuous probability distribution of a random variable whose logarithm is normally distributed (https://en.wikipedia.org/wiki/Log-normal_distribution). **The Pareto distribution**—named after the Italian civil engineer, economist, and sociologist Vilfredo Pareto—is a power law probability distribution that is used in the description of social, scientific, geophysical, actuarial, and many other types of observable phenomena. https://en.wikipedia.org/wiki/Pareto_distribution

[40] **Gini coefficient** : For more details about Gini coefficient measurement, see chapter 1, section 1.4.

When looking at developing countries, the Gini coefficient is much higher, indicating very unequal societies: Bolivia 0.481 (2013), Brazil 0.415 (2014), Ethiopia 0.332 (2010), Chile 0.505 (2013), Haiti 0.608 (2012) (T. Stacey, 2015).

The Global Income Distribution Dynamics (GIDD) is an important tool for predicting reductions in inequality. This methodological approach illustrates its application on future series scenarios. Forward-looking macro scenarios are produced using the World Bank's LINKAGE model (D. van der Mensbrugghe, 2005).[41] Using the GIDD model and the Global General Equilibrium Model (LINKAGE) helps predicts a reduction in regional income inequality by 2030 (M. Bussolo et al., 2008).[42]

Global inequality remains very high, however, and it will continue to remain very high because it is driven by changes in inequality from both within and between countries. Such changes require active and comprehensive policy combinations that enhance social and growth aspects while targeting those on the lowest incomes. Such policies that could lead to such a change include the FNS concept.

2.14 The local and global consequences of hunger

The US government has discussed, with great interest, the consequences of hunger. It investigated the implications of population growth for US interests, leading to the National Security Study Memorandum 200 report being published in 1974. This document claimed that population growth threatened the security of the United States by causing political instability and civil unrest, particularly in developing countries. This report also identified 13 countries as being problematic,

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[41] The **World Bank's LINKAGE model** is a global dynamic computable general equilibrium (CGE) model maintained by the World Bank to support global policy analysis, such as trade policy, global savings, and investment. Its underlying database is the most recent Global Trade Analysis Project (GTAP). The database also includes various measures of domestic support, particularly with regards to agriculture in OECD countries. The model is recursive dynamic capturing population and labor dynamics, differential sectoral productivity growth, and the roles of savings and investment in capital accumulation. The model has been used widely in the World Bank's Global Economic Prospects reports.
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:20357492~menuPK:681018~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html

[42] **Global Income Distribution Dynamics (GIDD):** In this context, the World Bank Development Economics Department (DEC) developed GIDD as the first global CGE-microsimulation model. GIDD takes into account the macro nature of growth and economic policies and adds a microeconomic dimension to it, namely the household and individual level. GIDD includes distributional data for 121 countries and covers 90 percent of the world's population. GIDD also allows analyzing the impacts on global income distribution from different global growth scenarios and distinguishes changes due to shifts in average income between countries from changes attributable to widening disparities within countries.
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:21909753~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html

including India, Pakistan, Ethiopia and Brazil. These countries' contribution to population growth was 47%, making it difficult to control and avoid the consequences of hunger (NSSM 200, 1974; H.C. Blaney, 1980).

Hunger's consequences can be grouped into three levels: (1) the country level, (2) the regional level (several neighboring countries) and (3) the global level.

1) **Country level**: The country level includes the millions of impoverished people who suffer from malnutrition and hunger. It includes unproductive people who can hardly provide for their basic needs and are therefore very dependent on support from government or large organizations, such as the FAO (N. Danon, 2011). The reduction of hunger and poverty by using local resources and fostering growth within the manufacturing sector is a very hard task for governments to approach, but an inability to do so often results in social and political instability (FAO, 2002). Impoverished social groups can turn to violent riots that threaten a country's stability.

Joseph Stiglitz, a Nobel laureate for economics, argues about the link between economic damage and the ability to make a decent living and political instability**.** An example of his argument can be seen in the crisis affecting Indonesia in 1997. GDP dropped by 16%, and the salaries of low-income people fell by 25–30%. The Indonesian government received assistance from the International Monetary Fund (IMF) in the form of a national recovery plan that both caused a decline in wages and simultaneously raised the prices of food. A response to this plan came in the form of violent protests that paralyzed the country's economy and exacerbated the crisis even more (J. Stiglitz, 2006). Many analysts are very concerned about the population growth combined with economic stagnation in developing countries, especially those in Africa. They find an imbalanced condition between population resources, inevitably leading to famine combined with diseases, wars, and death. E. Messer et al. (2002) claim that like a barrel of gunpowder, the deterioration of the environment and poverty leads to civil violence. This implies that an intrinsic level of hunger expresses itself through violence, internal conflict, and an unstable regime.

2) **Regional level:** The regional level refers to a collection of neighboring countries or an area surrounding a hotspot of hunger. Such countries can be subjected to thousands of refugees entering their territory. Between 1974 and 1996, the number of refugees rose from 2.5 million to 23 million. The presence of large numbers of refugees threatens a country's food security, disrupts regional trade, puts extra burden on environmental resources, and challenges the economic and political stability (E. Messer et al., 2002). D. Scheschkewitz (2011) points out that hunger is also associated

with violence, provoking violent conflicts between countries in order to secure food and water. For example, the famine in the Horn of Africa caused serious territorial problems and violence, because people could not obtain food for their families, so they searched for ways out of hunger. They turned to fishing piracy, which is illegal fishing in international waters, along the coasts of Somalia. Although this could be seen as being political in nature, such acts were committed purely for survival.

3) **Global Level**: This aspect describes the social, political, and economic issues beyond the borders of a country that suffers from hunger. Jacques Diouf,[43] the Director General of the FAO, said that "the silent hunger crisis, affecting one sixth of all of humanity, poses a serious risk for world peace and security" (N. Danon, 2011; FAO, 2009). Hunger crosses both physical and political boundaries, with the former involving migration movements both at the local level and between countries. Underdeveloped countries suffering from hunger, famine, and armed conflict can result in a massive migration flow toward developed countries in Europe, the Americas, and so on. The more that hunger grows in Africa, the faster the rate of illegal immigration into Europe will be, with a similar trend being identified in the United States. In 2011, 75,000 refugees infiltrated Spain, Italy, Malta, and Greece by sea. These immigrants, although now in developed countries, posed a threat to local economies, particularly to the detriment of the middle and lower classes, as they competed with local residents for sources of income. N. Danon (2011) argues that the following negative scenarios could potentially follow such massive immigration: (a) xenophobia followed by internal unrest, (b) migrants becoming a political objective and other groups, (c) a fertile ground for terrorist activity and anti-western movements like al-Qaeda,[44] and (d) increased power for fascist movements (N. Danon, 2011). Another supporting argument comes from Joachim von Braun (2011),[45] who states that a famine zone affects both political and global security. Migration and conflicts over land lead to local instability, but these conflicts also reflect on the entire world (D. Scheschkewitz, 2011).

The global economic crisis is now greater than ever. International experts in food and nutrition point out that as the annual growth rate of crops slows down, the world's population,

[43]**FAO Director-General Jacques Diouf**- 19 June 2009, Rome
http://www.fao.org/news/story/en/item/20568/icode/
[44]**al-Qaeda**: https://en.wikipedia.org/wiki/Al-Qaeda

[45] **Joachim von Braun** is a Director of the Center for Development Research (ZEF) and Professor for Economic and Technological Change at University of Bonn, Germany. https://sites.google.com/site/joachimvonbraun/

especially that of developing hunger-stricken areas, is still expected to grow, leading to a significant reduction in food and nutritional security. This could cause unrest at the local level but also on a wider level (E. Messer, 2002; IMF, 2008).

Hunger is a serious phenomenon that has an imposing presence in developing countries. It can be correlated with social, economic, and political problems, as well as environmental consequences. Although it is often depicted as a local problem in developing countries, we can clearly see how it exerts a much wider influence.

Addressing the hunger problem is a matter of ensuring food security and meeting basic nutritional needs. A new concept that describes these two goals is food and nutrition security (FNS), which is discussed below.

2.2 Food and nutrition security in the chosen countries

Achieving food and nutrition security is a rather complex task. FNS programs are based on specific strategies that identify and address the nutritional problems of targeted groups with the aim of improving their food security and nutrition, as well as their social position (R. Gross et al., 2000). The promotion of sustainable agricultural practices—such as ensuring access to quality inputs, strengthening market links, integrating soil and pest management, and improving water and soil conservation—takes place in some developing countries.

The following four examples depict the FNS problem in practice and present different sides of it: Africa's Ethiopia, Angola, and Zanzibar and Asia's India. Most countries in Africa have a great need for improved FNS. Geographic location and economic instability have been two major reasons for why most African countries have poor food and nutrition security. These countries usually have weak environmental policies and only have limited resources available for improving their outcomes. In 2016, about 230 million people in Africa were malnourished, 58 million children were stunted, and 164 million women and children were anemic. Most of Africa's population, about two-thirds, live in rural areas far away from urban regions. This makes the fight to stop hunger and to improve agricultural productivity an important and urgent mission for many African

countries. Two regional initiatives, the Malabo Declarati[46] and the CAADP,[47] have made efforts promote sustainable transformations in agriculture. There has also been a growing recognition that African agriculture and food and nutrition security is a vital priority. The FNS needs in Africa are greater than that of any other region, because Africa contains the ten countries with the greatest FNS problems in the world. A goal has been set to reduce the undernourished in Africa by 2030, and achieving this goal will require the use of two domestic policies: (1) agricultural economic policies that include issues concerning rural investment climates and (2) pricing domestic agricultural markets and prioritizing the nutritional targets of FNS (K. Homi et al., 2016).

Angola: The FAO argues that Angola's food insecurity problem is about the lack of fulfilment of food rights (FAO, 2011). The core issues that affect the most vulnerable groups in CPLP countries are food and nutrition security.[48] There are about 28 million undernourished people in CPLP countries, and Angola is one of the most problematic of these countries. Recent data shows that 37% of its population still lives below the poverty line, with 60% of these living in rural areas.

The National Strategy for Food and Nutrition Security (ENSAN) and the FNS Action Plan join together to address the goal of FNS in Angola**.** In order to improve food supply levels and the population's living conditions, the FNS concept acts to increase agricultural production, livestock, and fisheries in a sustainable manner. As presented in the National Strategy of the FNS, some of Angola's main findings regarding FNS policies were improved (J.N. Pinto, 2011).

Ethiopia: Ethiopia as a country is severely affected by malnutrition, and it is one of the world's least developed countries. Ethiopia cannot meet the rising demand for food and nutrition, so it fails to achieve three goals of FNS: food availability, food accessibility, and food intake adequacy. Food

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[46] **The Malabo Declaration**- on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods is a set of new goals showing a more targeted approach to achieve the agricultural vision for the continent which is shared prosperity and improved livelihoods. The Malabo Summit reconfirmed that agriculture should remain high on the development agenda of the continent, and this is a critical policy initiative for African economic growth and poverty reduction. http://pages.au.int/sites/default/files/Malabo%20Declaration%202014_11%2026-.pdf

[47]**CAADP**: Comprehensive African Agricultural Development Program is transforming Africa's agriculture for shared prosperity and improved livelihoods by harnessing opportunities for inclusive growth and sustainable development, also marking the tenth anniversary of the adoption of the Comprehensive Africa Agriculture Development Program (CAADP)". http://pages.au.int/sites/default/files/Malabo%20Declaration%202014_11%2026-.pdf

[48] **CPLP** is the Community of Portuguese Language Countries (Comunidade dos Países de Língua Portuguesa). It is an intergovernmental organization of Lusophone nations across four continents where Portuguese is an official language, mostly of former colonies of the Portuguese Empire. The CPLP operates as a privileged multilateral forum for the mutual cooperation of governments, on both executive and ministerial levels, non-governmental organization, and the various branches of the CPLP itself. http://www.unesco.org/new/en/brasilia/about-this-office/networks/specialized-communities/specilized-communities-clt/cplp/

availability is severely restricted due to disasters such as drought, floods, and war. Food accessibility, meanwhile, is limited because the economy mainly relies on agriculture and there are no income alternatives or other coping mechanisms. Finally, its food intake adequacy is not met due to food shortages and improper diets. Furthermore, the food aid programs provided are not meeting the requirements for food quantity and composition, and they encounter logistical problems. The region's FNS analysis concluded that food aid alone could not meet the region's increasing requirements. On the other hand, a sustainable approach and the development of natural resources could solve many farmers' problems (D. L. Kaluski et al., 2002).

Zanzibar: This country's problem with food and nutrition insecurity relates to its demographics and the socioeconomic, environmental, and political conditions. Food security is characterized by low, unsustainable local production. In 2008, Zanzibar's government focused on addressing the country's food security and nutritional problems while linking it with reducing the country's poverty level. Food and nutrition insecurity exists strongly in both Zanzibar's rural and urban areas. Their main obstacle is households' inability to acquire adequate and appropriate levels of food. In recent years, Zanzibar's government has committed to fighting food and nutrition insecurity by adapting and implementing national policies, frameworks, and programs. According to Vision 2020,[49] the government adopted the Agricultural Sector Policy (ASP) and the Agricultural Sector Strategic Plan (SP), focusing on agricultural productivity as a key aspect for food security (RGoZ, 2008; Sibanda, 2010). In 2010, however, rural poverty remained at the same tragic level as before. According to a Zanzibar household survey report, only a slow decline was achieved in poverty and food and nutrition security (S. A. Salum, 2016). More supporting data was presented in a report published by REPOA in 2016.[50] This pointed out that the proportion of the population below the line for basic needs slightly declined from 35.7% in 2000/01 to 33.6% in 2007. Over the same period, the country's food security fell from 18.7% to 16.6%. In conclusion, NSGRP's[51] targeted goals to reduce poverty were not met, and this left the country unable to meet its MDG[52] goals for poverty reduction by the end of 2015 (K. Blandina et al., 2016; S. A. Salum, 2016).

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[49] **Zanzibar Vision 2020**: Zanzibar's strategy for growth and reduction of poverty.

[50] **REPOA**: The Research on Poverty Alleviation is an independent research institution that creates and utilizes knowledge to facilitate socioeconomic development. https://www.africaportal.org/partner/research-poverty-alleviation-repoa

[51] **NSGRP**: National Strategy for Growth and Reduction of Poverty

[52]**MDGs,** or Millennium Development Goals, are the world's time-bound, quantified targets for addressing extreme poverty in its many dimensions (income, poverty, hunger, disease, lack of adequate shelter, and exclusion) while

India: In 2010, India was one of the most populous countries in the world with a population of 1.2 billion people. Ensuring food and nutrition security is therefore a very great challenge for this country. For India, food security is not just about the availability of food grains but also the composition of the overall food basket. This country suffers from a striking imbalance in fruit and vegetable consumption (D. Angus et al., 2009). Additionally, as D. Laborde Debucquet et al. (2016) report, while India stands at the top for fruit and vegetable production in the world, its own vegetable intake remains low. India's government, along with public sector programs related to food and nutrition security, recognizes the importance of food production, as well as improved economic access to food, in order to attain better nutritional outcomes. The government of India has boosted its agricultural investment through the National Agriculture Development Program, the National Food Security Mission, and other related programs that were introduced in order to achieve food and nutrition security. These programs, such as the central plan for 2010–2011 of the agriculture department, were worth around $2.5 billion. The Indian Council of Agricultural Research (ICAR) plan also cost about $480 million. Despite a huge network for delivering agricultural inputs and services, its outcomes did not fulfil expectations, and the quality of the services remained poor. India still faces the challenge of ensuring food and nutrition security and reducing poverty (T. Nandakumar et al., 2010; D. Angus, 2009).

Although there was some positive impact and progress was made in food and nutrition security, it remains a complicated concept to put into practice. Failure to achieving goals of FNS means the challenges of poverty, hunger, and inequality are still major issues. These topics are presented in the next chapter.

2.3 The role of sustainable agriculture and small farms

Agriculture is the single largest trade in the world, providing the largest source of income and jobs to poor rural households, as well as 40% of today's global population. In many parts of the developing world, 500 million small farms, many still rainfed, provide up to 80% of the food consumed. The role of stainable agriculture in small farms is essential to alleviating hunger and inequality in developing countries.

promoting gender equality, education, and environmental sustainability. These are also basic human rights, the right of each person on the planet to health, education, shelter, and security. http://www.unmillenniumproject.org/goals/

Agriculture faces many challenges because it is becoming increasingly difficult to grow enough additional food to feed the world's growing population, including the millions of hungry people who mostly reside in the rural areas of developing countries. The global food system is increasingly threatened by land degradation, climate change, and other stressors, and this mostly reflects on the small rural farmers of developing countries. In order for agriculture to play a more effective role in reducing poverty and malnutrition, as well as become more ecologically sustainable, it must meet the rising demand. Most of the world's poor people live in rural areas, and agricultural growth has proven to be effective at lifting such rural families out of poverty and hunger. What is more, agriculture remains the single largest employer of people in the world, providing 40% of today's global population with a source of income. Five hundred million small farms worldwide supply up to 80% of the food consumed in a large part of the developing world (FAO, 2012). Since the 1900s, approximately 75% of crop diversity was lost from farmers' fields. For decades, there was no motivation to work on the land, or indeed any encouragement from the IMF, World Bank, or any other programs or policy (T. Lang et al., 2012). The emerging agenda of sustainable agriculture focuses on improving agricultural systems and addressing rural development in an integrated manner. Sustainable agriculture offers workable options to eradicate poverty and hunger while improving the environmental performance of agriculture. This new vision and business model for smallholder agriculture and rural development is expected to create large numbers of jobs and help improve people's economic situation by providing new opportunities for communities in rural areas. It is thought to have the potential to ultimately reduce poverty and bring a solution to the millions of hungry people living there (A. Dobermann et al., 2013).

Sustainable agriculture as a concept has been promoted since the publication of the Brundtland Report in 1987.[53] It is a very vague and ambiguous concept that is extremely difficult to implement. The U.S. Congress on Food Agriculture Conservation and Trade Act defined sustainable agriculture as an "integrated system of plant and animal production practices, having a site-specific application that will, over the long term: (a) satisfy human food and fiber needs, (b) enhance environmental quality, (c) make efficient use of non-renewable and on-farm resources,

[53] **Brundtland Report, 1987**: *Our Common Future,* known as the Brundtland Report, was published in 1987 and was the outcome of work by the World Commission on Environment and Development. The report laid out the concept of sustainability as containing environmental, economic, and social aspects. http://www.un.org/esa/sustdev/csd/csd15/media/backgrounder_brundtland.pdf

and integrate appropriate natural biological cycles and controls, (d) sustain the economic viability of farm operations, and (e) enhance the quality of life for farmers and society as a whole" (B. Farm, 1990, Sec. 1619, Purpose and definitions). As for R. G. MacRae (1989), sustainable agriculture is a management procedure that works with natural processes to conserve resources, minimize waste and environmental impact, prevent problems, and promote agro-ecosystem resilience, self-regulation, and the evolution and sustained production for the nourishment and fulfillment of all (R. G. MacRae, 1989; B. Farm, 1990; S. Velten et al., 2015).

Sustainable agriculture is not just possible—it is successfully being practiced in many places around the world. Pretty (2006) presents the impacts of 198 projects that demonstrated significant yield increases (a one-to-eight-fold improvement) because of sustainable agriculture techniques (I. Granoff et al., 2015). Below are some sample sustainable agriculture projects that have been implemented in developing countries, thus showing their different facets.

Bolivia's Program to Promote Sustainable Agriculture (PROAGRO): This program promoted access to water and water availability for agricultural production for smallholder farming in the semi-arid parts of Bolivia. The program worked with farmers to find ways of improving production, safeguarding yields, ensuring the sustainable use of productive resources, and making water management more efficient. As a result, more than 12,000 families received access to irrigation water, and 20,000 hectares now have access to irrigation water, thus minimizing water conflicts. In addition, family incomes have risen by approximately 130%. This convinced the Bolivian Government to launch a national irrigation program, which publishes guides for planning and designing small-scale irrigation systems.

Niger's Climate Change and Severe Droughts. The desert, water, poor soil resources, and the severe droughts of the 1970s and 1980s are some of the problems facing this country. In addition, rapid population growth, the expansion of arable land, and inappropriate farming methods have all contributed to an increased pressure on the land and led to soil degradation and desertification. The Deutsche GIZ[54] has worked with the Niger government for over 20 years and supported it in sustainable resource management for farming and rehabilitating degraded soil. The

[54] **Gesellschaft für Internationale Zusammenarbeit** (**GIZ) is** the German Federal Enterprise for International Cooperation. GIZ works worldwide in the field of international cooperation for sustainable development. It provides viable, forward-looking solutions for political, economic, ecological and social development in a globalized world. GIZ has operations in more than 130 countries in Africa, Asia, Latin America, and Central Asia. http://en.openei.org/wiki/Deutsche_Gesellschaft_f%C3%BCr_Internationale_Zusammenarbeit_(GIZ)_GmbH

project worked with farmers and livestock owners to develop water and soil conservation. As a result, more than 500,000 hectares of land yielded about 200 kg more millet per hectare than before, which is equivalent to one person's cereal requirements for a year. The increase in the local groundwater level allowed vegetables to be grown during the dry season, improved incomes, and allowed a more varied diet.

Ethiopia and Sustainable Land Management: In Ethiopia, land degradation has been increasing annually, with up to 1.5 billion tons of fertile farmland being lost. This has created deep erosion channels that are several meters wide. Due to degradation, each year up to 300 km^2 of arable land has become unusable for farming, thus reducing yields as well as food security. The Ethiopian government has therefore launched a national program for sustainable land management with financial aid from several donor organizations. This provided special training to different advisors, smallholders, and other user groups in the hope of better using resources and farming techniques in the fields and grasslands. As a result, soil fertility and water availability improved, and farmers can now generate more income from their land. Furthermore, by 2014, about 200,000 hectares of agricultural land had been rehabilitated. Productivity was increased by up to 35%, which resulted in significantly more income for about 80,000 households and 400,000 people. The success of the program encouraged the Ethiopian government to roll out such methods in other regions (K. Stephan, 2015).

It is in developing countries that some of the most significant progress toward sustainable agro-ecosystems has been made over the past decade. The largest study conducted analyzed 286 projects in 57 countries. The classification of farming systems, as specified in Table 14, is based on a number of key factors adopted by the FAO,[55] including (i) the available natural resource base; (ii) the dominant pattern of farm activities and household livelihoods, including the relationship with markets; and (iii) the intensity of production activities. It contains a summary of the location and extent of the 286 agricultural sustainability projects in the 57 countries. Overall, 12.6 million farmers on 37million hectares of land were moving toward agricultural sustainability in these 286 projects. Twenty-five percent of the projects reported a 100% increase in yields, while others

[55] **Farming systems and their characteristics**: Eight broad categories of farming systems have been distinguished: ● irrigated farming systems ● wetland rice-based farming systems ● rainfed farming systems in humid areas ● rainfed farming systems in steep and highland areas ● rainfed farming systems in dry or cold low potential areas ● dualistic (mixed large commercial and small holders) farming systems across a variety of ecologies and with diverse production patterns; ● coastal artisanal fishing systems; and ● urban-based farming systems typically focused on horticultural and livestock production. http://www.fao.org/3/a-ac349e.pdf

had yield increases ranging from 18% to just under 100%. At this stage, it is unclear whether progress towards more sustainable agricultural systems will result in enough food to meet the demand in developing countries while population growth continues (J. Pretty, 2008).

Table 14: Summary of the adoption and impact of agricultural sustainability technologies and practices in 286 projects through 57 countries

FAO farm system category	Number of farmers adopting	Number of hectares under sustainable agriculture	Average % increase in crop yields
Smallholder irrigated	177287	357940	128.8(±21.5)
Wetland rice	8711236	7007564	22.3(±2.8)
Smallholder rainfed humid	1704958	1081071	102.2(±9.0)
Smallholder rainfed highland	401699	725535	107.3(±14.7)
Smallholder rainfed dry/cold	604804	737896	99.2 (±12.5)
Dualistic mixed	537311	26846750	76.5 (±12.6)
Coastal artisanal	220000	160000	62.0 (±20.0)
Urban-based and kitchen garden	207479	36147	146.0 (±32.9)
All projects	12564774	36952903	79.2 (±4.5)

Source: own elaboration, Data: J. Pretty (2008)

We can conclude that sustainable agriculture has the potential to increase yields and help feed the world's growing population without destroying the resources needed for human survival. Sustainable agriculture presents an opportunity to rethink the importance of rural communities, and when used in combination with other strategies, its practices and policies can help rural communities improve and achieve food security, especially in developing countries.

In Sub-Saharan Africa**,** the growth generated by sustainable agriculture is eleven times more effective in reducing poverty than growth in any other sector. Sustainable agriculture is already being practiced successfully, and it has become an essential element in improving livelihoods through sound investment in environmental practices. Sustainable smallholder agriculture provides a potential poverty-reducing pathway toward the elimination of hunger.

While significant increases in yields from sustainable agriculture techniques have already been demonstrated, it is no small task to accomplish the same on a very large scale. For example,

would the same sort of success be possible for all the 500 million smallholders in the world? At the same time, we cannot ignore that other hunger-management models already exist, and we also have some experience with these. Presenting and learning about the performance of these models is the aim of the next chapter.

Conclusions

In a world of plenty, the number of people suffering from hunger, malnutrition, and hunger-related diseases in developing countries is staggering. This chapter has provided some insights about the different aspects of hunger, such as the scope of hunger; hunger and a country's socio-economic profile; hunger and inequality; hunger's consequences; hunger and the concept of FNS in practice; and sustainable agriculture's role for small farms.

The FAO and other organizations report that the number of undernourished people worldwide is estimated at 854 million, with 820 million living in developing countries. In 2016, hunger levels were the highest in the Central African Republic. There is a wide consensus among different world organizations about the urgency of eliminating the hunger problem.

The socioeconomic profile of developing countries can give additional insights about their hunger problems. Where the hunger problem exists on a large scale in such countries, it often has its own unique characteristics. It is noteworthy, however, that developing countries can be grouped into six basic common socioeconomic profiles. In no particular order, these are (1) accelerated natural growth and constant threats to food security; (2) the serious failure of crops and subsequent hunger crises; (3) poor rural households; (4) high GHI indices; (5) an unstable economy; (6) internal and external challenges. With these socioeconomic profiles, the people in developing countries are more vulnerable to poverty and hunger than people in developed countries and suffer more as a result.

Hunger is a multidimensional phenomenon, and it has a wide-ranging effect on social, economic, and political issues on both local and global scales. Indeed, despite hunger in developing countries often being portrayed as a local problem, it has wide-ranging, cross-border effects. Hunger's consequences can be grouped into three levels: (1) the country level, where millions of unproductive hungry people depend on government assistance; (2) the regional level, where in neighboring countries, refugees threaten a country's food security, add burden to the environmental

resources, and challenge the economic and political stability; and (3) the global level, where serious hunger levels could jeopardize global peace.

Hunger is a social phenomenon that hints at the existence of inequality. Inequality has two perspectives: the inequality of opportunities and the inequality of outcomes in various dimensions of human wellbeing. The gap between the rich and the poor within countries, as well as between countries, can be gleamed through their gross domestic product per capita. Rich countries have a per capita GDP some 20–100+ times more than poor developing countries. In addition, differences are also expressed in Gini coefficients. Most OECD countries have a Gini coefficient of 0.32–0.24. In developing countries, however, the Gini coefficient is much higher, often more than double, which indicates very unequal societies (Gini coefficients of 0.608–0.415).

The hunger problem can be regarded as a matter of food security, as well as one of meeting basic nutritional needs. FNS is a leading concept to describe these two goals. FNS works simultaneously on four levels: food availability; food accessibility; food intake adequacy; and the stability of these three levels over time. The test case of selected countries in Africa and Asia demonstrates the great need for improvements in FNS, particularly in African countries. There has been a growing recognition that African agriculture, food, and nutrition security is a vital priority. This need partially derives from the geographic location, economic instability, weak environmental policies, and the limited resources available for countries to improve their outcomes. Promoting sustainable agricultural practices in developing countries is not an easy task, however, and this appears to be the case in some African and Asian developing countries, such as Ethiopia, Zanzibar, and India. The challenge there still needs to be addressed.

The role of sustainable agriculture in small farms has been found to be an important issue. In these small-scale farms, the role of stainable agriculture is an essential concept in alleviating hunger and inequality in developing countries. Most of the world's poor live in rural areas, so new agricultural systems have been proven to be effective at lifting rural families out of poverty and hunger. Some significant increases in yields through sustainable agriculture techniques have already been reported, but it is a considerable challenge to accomplish the same on a much larger scale, such as the country level.

Chapter 3: Hunger solution models

The *"hunger management models"* introduced in this study are driven by two insights, namely a country's profile and its existing hunger solutions.

Developing countries are characterized by a country profile that summarizes its performance through different socioeconomic and political indicators. It reflects the country's development level and the scale of its hunger problem. Such indicators can be based on the birth rate, the prevalence of HIV/AIDS, the HDI (Human Development Index), political stability, and government effectiveness. The social, economic, and political aspects of a developing country are critically important when predicting how well a country will succeed in addressing its hunger problem. For example, a developing country with low economic, social, and political performances might need to anticipate slower progress in reducing its hunger level over time (Schwab, 2013).

In the research literature, the most prominent solutions to the hunger problem in developing countries are based on the FAO's concept of *food security*. This basic approach focuses on addressing the causes of hunger while ensuring the availability of food at different levels (FAO, 2011). Some representative solutions are introduced in this chapter. Different programs keep the food security concept in its various aspects, but at the same time, they neglect the country's development level despite its important influence in fighting hunger.

The development level of a country can play an important role in fighting hunger. Countries with different development levels, and therefore different socioeconomic and political abilities, react differently to the same hunger programs in terms of the improvement in their GHI scores, as well as other indicators, over time. This insight is supported by the fact that existing solutions, such as the WFP (Wold Food Program), have been implemented in different countries. While there have been some positive achievements in reducing hunger levels over time, hunger is still considered a major problem in these countries. Indeed, most still fall into the "serious" category of the GHI Severity Scale. For example, the GHI indicated in 2018 that Mauritania (27.3), Nigeria (31.1), Mali (27.8), Guinea (28.9), Angola (29.5), and Tanzania (29.5) are all in the 20.0–34.9 "serious" range despite implementing the WFP hunger program (Global Hunger Index, 2018).

This reality indicates that eliminating hunger requires a pragmatic shift in how we address the hunger problem. There is a need to create new solutions based on a creative viewpoint. The

new concept and model to fight hunger that is presented here is based on the above two insights that will be introduced in the subsequent chapter. It is an original *hunger-management model* that applies an effective combination of existing hunger solutions for countries at different developmental levels. It is therefore a new and unique *hunger-management model* that could be considered as being based on outside-the-box thinking that is thus far unrepresented in the research literature.

3.1 Hunger: A global problem needing a solution

Hunger is a very real tragedy for more than 800 million people. It is a part of these people's everyday lives, and this cannot be allowed to continue (FAO, 2002). As the patterns of the post-2015 development agenda emerge, the international community has made great efforts to ensure that food and nutrition security is at the heart of the new development framework. Possible solutions to the hunger problem include food-based approaches, but there are also other solutions based on wider concepts to address the issue. This sub-section introduces the most prominent solutions presented in the research literature.

Global hunger has been a growing problem throughout the last century, and it continues to be a problem to this day. Hunger is mostly recognized as a social problem with a direct connection to weather conditions and the growing number of people in developing countries. Following World War I, hunger grew in the developing countries and was ultimately represented in the Millennium Development Goals.[56] The first major food-aid operations conducted by the US Congress came with the signing of the armistice that marked the end of World War I in 1918, followed by the signing of the Treaty of Versailles in 1919. During the reconstruction of Europe from 1919 to 1926, millions of tons of food were shipped to Europe by the US Congress. The significance of this action lay not just in the volume of relief provided to people who desperately needed it—it also established a precedent for operations of this nature and cultured a general realization of food aid's value as a politically stabilizing force (H. W. Singer et al., 1987).

More global hunger crises began around the time of the Great Depression and the period after World War II. During this time, food shortages threatened millions, and many people around the world struggled to purchase the food products they needed **(**S. Rogers, 2015).

[56] In September 2000, the United Nations Millennium Declaration set out a series of time-limited targets that have become known as the eight Millennium Development Goals (MDGs). The first goal is to eradicate extreme poverty and hunger. http://www.un.org/millenniumgoals/bkgd.shtmlhttp://www.un.org/millenniumgoals/poverty.shtml

Prior to World War II, the League of Nations had already recognized the need for some form of multilateral world-food-security arrangement (D. J. Shaw, 2007). In other words, there was a need to rationalize food production, supply, and trade for the benefit of both producers and consumers in both developing and developed countries. The focus was placed on two basic concerns: Firstly, it was desirable to avoid uncontrolled fluctuations in the world's agricultural production and pricing. Secondly, it was beneficial to constructively use agricultural surpluses[57] to help the economic and social development of developing countries. This subject of world food security subsequently re-emerged with the creation of the FAO.

At the same time, advances in nutritional science highlighted how chronic malnutrition has harmful effects on health, particularly among children and other vulnerable groups, even in relatively well-off countries. Following the Great Depression, the need for staple foods was questioned, a growing recognition of nutritional deficiencies strengthened, and an understanding developed where hunger solutions should be based on a selective expansion of food consumption. The need to promote measures to raise the real incomes of people in need was also emphasized (D. J. Shaw, 2007).

In the early 1930s, Yugoslavia indicated the importance of food for health and proposed that the League of Nations disseminate information about the food position in representative countries of the world. This report was the first to introduce the world food problem to the international political arena. The first report on Nutrition and Public Health was submitted by Frank Boudreau in 1935.[58] It revealed an acute food shortage in poorer countries, and this was the first account of the extent of hunger and malnutrition in the world.

Meanwhile, the hardships resulting from the economic crisis of the early 1930s, and subsequent fears of a recurrence, led governments to adopt national price and production controls for foodstuffs and other agricultural products in exporting countries, coupled with trade restrictions in importing countries. Furthermore, interest grew in regulating the world trade in foodstuffs and other staple products through intergovernmental action (D. J. Shaw 2007).

No action was taken by the League of Nations following the publication of the nutrition report until 1935, when the subject was again raised by Stanley Bruce in the League Assembly.[59]

[57] **Agricultural surpluses** are output in excess of commercial market demand.
[58] **Frank Boudreau** was head of the Health Division of the League of Nations.
[59] **Stanley Bruce** was high commissioner for Australia in London

The economic crisis had hit hard, international trade had decreased, and there was widespread unemployment in both Europe and the United States. Meanwhile, the only practices being applied were tariff barriers and other measures to restrict food production in order to raise prices. Bruce warned that "an economic system which restricted the production and distribution of the things that the majority of mankind urgently needed was one that could not endure." He predicted that disaster would ensue unless measures were taken to develop the potential wealth of the world in an expanding world economy (D. J. Shaw 2007). Bruce proposed that the League of Nations should establish how much more food was needed and identify what measures might be taken to get nations to cooperate in a global food plan based on human needs (F. Freidel, 1990, p. 387–8).

Out of this historical background emerged the FAO, with Frank McDougall being deeply involved in its founding (Boerma, 1968; Phillips, 1981).[60] Most of all, he was impressed by the development of nutrition knowledge between the two world wars. He also noticed the apparent paradox where food surpluses had emerged during the depression of the 1930s, yet hunger and malnutrition had affected the most economically advanced countries in addition to developing countries. One of his important achievements was inducing the League of Nations to set up an international committee on nutrition (R. W. Phillips, 1981). He also promoted to President Franklin D. Roosevelt the idea of creating an international agency to combat hunger, which ultimately led to the Hot Springs conference (D. J. Shaw, 2007).[61]

Following President Roosevelt's call for "freedom from want" (S. I. Rosenman, 1950), the FAO considered freedom from want as including a secure, adequate, and suitable supply of food for every person (FAO, 1943). After winning the war, the government's task was to deliver millions of people from the threat of hunger or in other words, achieve the declaration's goals. Since the declaration also stated that there has never been enough food for the health of all people,

[60] Frank McDougall was born in the United Kingdom, but he went on to become a fruit grower in Australia and later an economic adviser to Lord Bruce, the Australian High Commissioner in London. MacDougall had shown a keen interest in the work of Boyd Orr on human nutrition and had frequently visited his research institute in Scotland, keeping Lord Bruce informed as well.

[61] The Hot Springs conference was perhaps one of the most important international conferences ever held in any country. It took place in Hot Springs, Virginia from May 18 to June 3, 1943. This conference urged governments to act immediately. The first decision of the conference was to build upon the work in food and nutrition already accomplished by the League of Nations. Reports on the work of the League were presented to the conference, and they had a marked influence on its recommendations. For example, in 1935, the League had urged governments to set up national nutrition committees to study food and nutrition problems and recommend suitable nutrition policies and programs to the appropriate agencies.
http://onlinelibrary.wiley.com/doi/10.1111/j.1753-4887.1943.tb07864.x/pdf

food production had to be greatly expanded. This was feasible thanks to the existence of the knowledge and the means needed to expand food production (D. J. Shaw, 2007).

The main goal of the FAO between 1945 and 1970, as its constitution put it, was "to ensure humanity's freedom from hunger." Over the years, various bodies were established to achieve world food security. The first director-general of the FAO, Lord Boyd Orr from the United Kingdom, proposed the establishment of a World Food Board as an international means to achieve world food security by addressing the issues of nutrition, health, agriculture, trade, and industry.

Throughout the 1950s, it became clear that the major industrialized countries, particularly the United States and the United Kingdom, did not accept the world food security arrangements established under the multilateral control of the United Nations body. This limited the activity of the FAO, so it kept the ambition of world food security alive through a series of pioneering studies, reports, and proposals, such as the establishment of a World Food Reserve to meet food-shortage emergencies, regulate excessive price fluctuations, and constructively make use of accumulated food surpluses. It also suggested the creation of national and regional food reserves in developing countries and various types of international commodity agreements.

In 2007, a different approach to hunger was adopted by the new director general of the FAO, B. R. Sen from India. He realized that a new approach to hunger was needed, so he launched the worldwide Freedom from Hunger Campaign. He wanted to raise public awareness through education and information about hunger, and this was designed to pressure governments into taking action and establishing more international awareness programs. This led to food aid not just being considered as a way to meet food-shortage emergencies caused by natural and man-made disasters but also as a means to advance economic and social development in developing countries. This resulted in the establishment of the World Food Program, the food aid arm of the United Nations. According to Shaw, "It was recognized that no lasting solution to the problem of hunger could be found without balanced economic and social development." Years later, the "Freedom of Hunger Campaign" came to an end (D. J. Shaw, 2007).

A turning point came with the worst world food crisis in modern times in the early 1970s, which led to the UN World Food Conference of 1974. The United States pushed for the conference to adopt 20 substantive resolutions to eradicate world hunger and malnutrition. The action taken on some of the more prominent resolutions includes: The International Undertaking

on World Food Security, an international grain-reserve system, and an international emergency food reserve, as well as international trade, stability and agricultural adjustment.

In 1976, Edouard Saouma, the new FAO director general from Lebanon, placed food security as the central focus of the FAO's work, including the Food Security Assistance Scheme, a special action program for the prevention of food losses, and the expansion of national and regional food-storage facilities. One of his important steps, which was made in 1983, was to revise the FAO's concept of world food security by building upon the two pillars of increased food production and stability of food supplies. This third pillar mandated access to food by the poor, thus differentiating the world food problem from simply food security and ushering in issues that previously went beyond the FAO's mandate. Edouard Saouma also proposed a Plan of Action on World Food Security and a World Food Security Compact.[62] This brought him into conflict with leading industrialized countries, who continued to resist any attempts to establish multilateral world food security arrangements beyond their control. The World Bank's interest in food-security issues was presented in a seminal study in 1986. It pointed out the need to distinguish between transitory food security and chronic food security and called for different policies and programs in their solution.

During the 1990s, a series of international conferences mostly related to world food security, resolutions, and goals and targets for several important issues took place. The most prominent issues related to global hunger, children, the environment, water resources, nutrition, social development, food, agriculture, women, and food security. The outcomes of these conferences were reflected in a series of commitments. These conferences ended with the Millennium Summit at the United Nations in 2000, where world leaders agreed to specific millennium development goals and targets, including halving the proportion of the world's population suffering from hunger. In 2005**,** at the World Summit at the United Nations, world leaders reiterated their commitment to achieving the millennium goals set at the 2000 summit. This was an important turning point in understanding hunger as a global issue rather than a local

[62] **The World Food Security Compact** brings together general principles and suggestions for action by governments, organizations and individuals. Because of the very diverse circumstances in different areas, actions that are appropriate in one location or situation may not be suitable in another. Measures to strengthen food security must therefore be carefully tailored to match the specific problems they are intended to resolve http://www.fao.org/docrep/x5562E/X5562e07.htm

phenomenon. Furthermore, the world hunger crisis has brought a new response to this massive problem, namely the goal of ending world hunger in its different forms.

3.2 Different hunger solutions

The millennium development goals agreed in 2000 marked a turning point in achieving world food security and eliminating hunger. Cohesive actions to reduce poverty and hunger were now not just a moral imperative issue but also for the sake of a just, equitable, and peaceful world with economic and social development. Over the years, the various dimensions of hunger have attracted different solutions from organizations, agencies, and governments, resulting in numerous approaches to eradicating hunger. Moreover, the financial side has also been put forward as an important aspect in this issue, with it being considered the driving force for any solution. Thus, in 2002, the International Conference on Financing for Development took place, during which commitments were made to provide the resources needed to achieve the millennium development goals.

Two basic approaches can be distinguished in various hunger solutions. The first is based on the assumption that food deficiency is the main problem causing hunger in developing countries. Based on this concept, the literature proposes different ways to eradicate hunger in developing countries. The second approach, meanwhile, has attracted considerable support by proposing a broader and more complex approach to solving the hunger problem. This concept is based on the assumption that world hunger is not so much a problem of insufficient food but rather an inability to get food to those who need it. Such an approach sees hunger as a complex, multi-dimensional problem that requires a multi-faceted solution through a variety of efforts. For example, stable economic, social, and political conditions are believed to reduce hunger in developing countries. This work refers to the first approach as a **one-dimensional** hunger solution model. [63] The second concept, meanwhile, is considered a **multi-dimensional** hunger-solution

[63] The one-dimensional hunger-solution model emphasizes that the solution focusses on one channel of activity this is believed to eradicate hunger. For example, boosting agricultural food production, or similar efforts, is considered to be a one-dimensional model. This could involve using a drought resistant crop or a better type of grain to try and solve the world hunger problem.

model. [64] This subsection focuses on these two hunger models, presenting leading hunger solutions for each of them.

3.2.1 One-dimensional hunger-solution models

3.2.1.1 Food subsidies

Agricultural input subsidies ensued after the structural adjustment and market liberalization reforms of the 1980s and 1990s. Agricultural input subsidies are mainly used in African countries, but, after the 2008 global food price crisis, many countries witnessed severe food shortages and civil riots. To protect against similar crises arising in future, many governments introduced input subsidies and various price-stabilization schemes. The governments introducing these interventions were aware of the potential fiscal burden that such interventions could have on their economies, but the political imperative to stabilize prices and ensure food security was too important to ignore. Consequently, the debate about subsidies shifted away from whether or not to use them and toward how to implement them effectively and efficiently. In addition, the general consensus in development circles began to shift over to the design and implementation of smart subsidies (targeted subsidies) that target support at the poor rather than undermine the development of private agricultural input distribution markets. Agricultural subsidies have since been introduced in many African countries.[65] What is more, many donors who traditionally resisted subsidies are now increasingly providing aid in the form of subsidies (S. Benin et al., 2013). The important role that food subsidies and direct interventions can play in alleviating hunger and malnutrition was recognized by ministers from developing countries at the 17th session of the WFC (World Food Council) in 1991, which also recognized that economic policies and measures to fight hunger and poverty were primarily a domestic responsibility (D. J. Shaw, 2007). Furthermore, it was noted that hunger and poverty were already being given greater attention in development cooperation. The interest in consumer food subsidy programs was therefore accentuated during the 1980s, not just out of concern for the increasing number of hungry people in developing countries as their access to food decreased but also

[64] Multi-dimensional hunger solution model- such model seems hunger as a complex, multi-dimensional problem that requires a multi-pronged solution. In this case it is needed to work simultaneously on several channels related to hunger. Examples of such efforts are: support for family farmers, school feeding programs, food access and more.

[65] **African countries**- agricultural subsidies have since been introduced in many African countries such as Ghana, Malawi, Nigeria, Tanzania, and Zambia at the forefront. These countries now spend a large share of their public agriculture expenditures on agricultural subsidies. Evidence of this policy can be found in the study of Samuel Benin et al, 2013.

because of the social dimensions of the structural adjustment program that the World Bank and International Monetary Fund (IMF) were advocating, as well as the need to find effective compensatory measures to protect the poor during the process of economic adjustment.

Research undertaken by the IFPRI (International Food Policy Research Institute) over the 1978–1986 period provided the results of consumer-oriented food subsidy programs in a diverse range of developing countries (P. Andersen, 1988). These programs had different objectives, including improving the real purchasing power and nutritional status of the poor and ensuring social and political stability by protecting poorer households from further deteriorations in their already low standards of living while structural adjustment programs were implemented. They also took many forms, such as direct government finance or indirect support through fiscal or exchange rate policies. Some were generally applied, while others were targeted at specific population groups. The IFPRI research showed that most subsidy programs were not targeted at the poor, concluding that a "consumer food subsidy program should be seen as a temporary but important means to ensure that the poor can acquire sufficient food for nutritional requirements while such capacity is being created." To be cost-effective, though, it said that "it is essential that the program be targeted." The most important lesson learned was how consumer food subsidies can be "a powerful and cost-effective policy tool to reach certain social, economic, and political goals, or they can be harmful to growth and equity," depending on when and how they are applied. (D. J. Shaw, 2007).

Farm-support subsidies and agricultural subsidies are policy solutions that aim to sustainably end hunger and malnutrition and reduce poverty. Direct government interventions in agricultural production and market manipulation through agricultural input subsidies and farm-support programs were common elements in African agricultural development in the 1960s and 1970s (M. Kherallah et al., 2002). The prevailing opinion at the time was that market interventions through input delivery systems, subsidies, and output procurement schemes were inefficient and ineffective because of their distortionary effects on resource allocations and production patterns based on comparative advantage (S. Benin et al., 2013). Nevertheless, the justifications for input subsidies, and their subsequent effects, are complex and often controversial, but they have been helpful in promoting the adoption of better technologies and practices during the early stages of development (S. Benin et al, 2013).[66]

[66] Such as during the successful Green Revolutions in Asia, for example

Five popular subsidy programs have been implemented by different African governments when the overarching goal was to:[67]

- increase agricultural output and productivity;
- subsidize agricultural mechanization services through support for the establishment and operation of agricultural mechanization service centers (AMSECs);
- subsidize fertilizers through a national fertilizer subsidy program (FSP);
- establish and manage block farms that benefit from subsidized mechanization services inputs (e.g., fertilizers, improved seed, and pesticides), and extension services; and
- stabilize output prices via the establishment and operation of a national food buffer stock company (NAFCO) (S. Benin et al., 2013).

Food subsidy programs had a positive effect on household food security and nutrition in several countries. The provision of fixed rations at pre-determined prices was particularly effective in ensuring households' access to staple foods, especially in urban areas. Food consumption among low-income consumers also increased (OECD, 2010).

Evidence from different case studies in Asia and Africa—such as India, Malawi, and Sri Lanka—shows that subsidies have had an impact over the short-to-medium term in terms of promoting input use and raising output, thus reducing poverty. In addition, these studies point out that much of the effectiveness of subsidies depends on how the programs are designed and operated. Targeting is found to be an important issue in subsidy programs, with possible criteria being farm size, location, and the production of particular crops. Such targeting can make subsidies more likely to achieve their goals economically, with subsidies being offered to specific farmers on social policy grounds. This can improve the chances that a subsidy achieves the intended aims (OECD, 2010).

3.2.1.2 Feeding programs and food aid

Food aid has long been a common response to the global hunger problem. Some 200 million people depend on food aid every year. In cases of acute food shortages, particularly when a crisis affects vulnerable people who are already suffering from chronic undernourishment, such aid can literally be a lifesaver for them. What is more, dietary intervention in the first two years

[67] For example, in Ghana since 2007, different subsidy programs were implemented.

of a child's life can lead to enormous improvements in both long-term health and quality of life (J. Clapp, 2015).

There are various, sometimes conflicting, definitions for food aid in the literature (D. J. Shaw and H. W. Singer, 1996). In addition, there is a gap between the conceptual definitions adopted by food aid practitioners and those favored by academic analysts. The food aid practitioners' definition includes all forms of food-supported interventions to abate food insecurity in all countries, including richer donor nations. Meanwhile, the academic analysts, who have written much of the empirical literature on food aid, tend to use a more limited definition of food aid (T. O. Awokuse, 2011).[68] The dictionary definition of food aid, meanwhile, describes it as "food donated, either by a foreign government or by a charitable organization, to people in need, usually in developing countries."[69]

In the early 1950s, food aid originated as a form of assistance to developing countries when structural surpluses of cereal products manifested in the United States. It thus comprised food commodities procured from the donor country's internal market (or through international markets) and shipped free of charge to a recipient country. A large part of food aid continued to be associated with the disposal of surpluses throughout the 1980s and 1990s. However, as the pressure of surplus disposal gradually weakened, and as the food aid programs of donor countries became more responsive to their recipients' needs, other forms of food aid emerged. There was therefore a move away from surplus disposal. To a large extent, food aid was no longer a form of surplus disposal but rather an integral part of the overall development assistance budget (FAO, 2002).

Modern food aid began in the USA with the passage of United States Public Law 480 (PL 480) in 1954 (T. O. Awokuse, 2011). Other countries gradually followed suit, especially in the context of official development assistance. This led to the creation of the World Food Program (WFP) in 1961, which was designed to broaden the resource base of food aid and provide a multilateral basis. The WFP is currently the largest multilateral food aid agency (FAO, 2002).

For Sophia Murphy and Kathy McAfee (2005), three criteria distinguish food aid from non-aid transfers of food and non-food development aid. (1) Food aid must cross at least one

[68]The limited definition of food aid says that food aid is a default response to emergency needs, usually in the form of in-kind direct transfers of food (Humanitarian Policy Group, 2010). https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6038.pdf

[69] https://www.collinsdictionary.com/dictionary/english/food-aid

international border. Food assistance by a government or private agency to local citizens, such as the food stamp program in the U.S, does not count as food aid.[70] (2) Food aid must be "concessional," so it must be either provided free to the recipient or at least at a cost lower than the commercial price of the food involved. (3) Food aid must come either in the form of actual food (known as direct transfers) or in the form of funds or goods that can be exchanged for food (S. Murphy and K. McAfee, 2005).

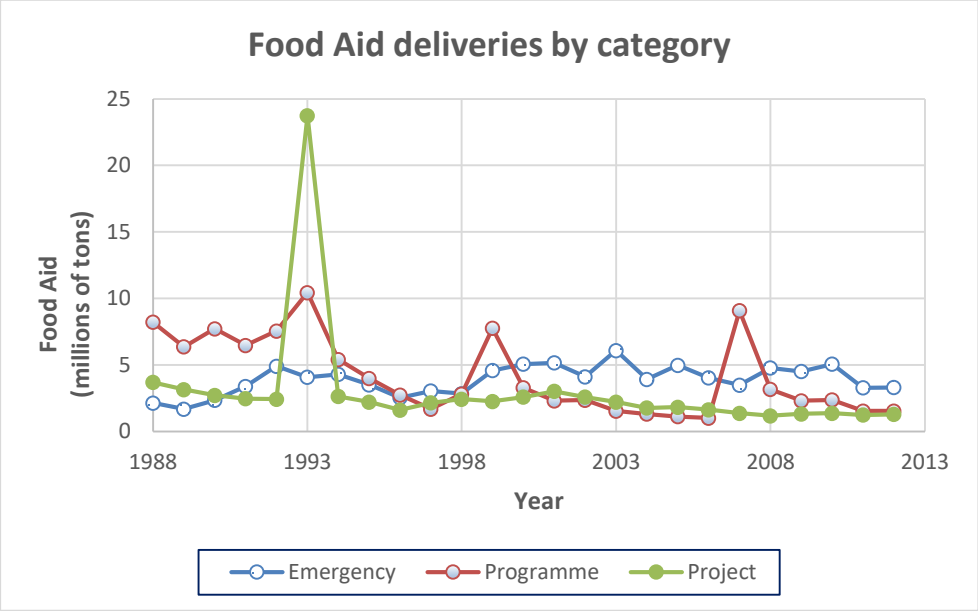
Under the broad heading of food aid, the World Food Program recognizes three categories of aid based on the different ways in which they contribute to food security: (1) **program food aid**, (2) **project food aid,** and (3) **emergency food aid**. Although the line between these three categories is not always clear, program, project, and emergency food aid are distinguished by the different purposes they serve, namely budgetary support, support for development and nutrition programs, and emergency feeding (S. Murphy and K. McAfee, 2005).

(1) Program Food Aid involves the transfer of food from one government to another as a form of economic support. Some program food aid is donated to recipients, while the rest is sold on concessional terms. Often the donor will finance the sale of food by a private firm to the recipient government by extending an export credit that the recipient government then pays back on favorable terms. In the 1960s, most food aid was of this nature, but program food aid has been declining as a proportion of total food aid.[71] Program food aid was designed and used to dispose of commodity surpluses in donor countries that could not find a commercial market for them. For this reason, because such surpluses can vary enormously from year to year, program food is the most volatile category of food aid, as reflected in Figure 4 (S. Murphy and K. McAfee, 2005; C. B. Barrett and D. G. Maxwell, 2005; T. O. Awokuse, 2011).

[70]The Food Stamp Program provides food-purchasing assistance for low/no-income people living in the U.S. This federal aid program is administered by the U.S. Department of Agriculture under the Food and Nutrition Service (FNS). https://www.usa.gov/food-help

[71] Program food aid has been declining. In the 1990s, program food aid accounted for an average of 49 percent of all food aid. In 2000, this had dropped to 26 percent of the total, and by 2004, it fell to less than 15 percent.

Figure 4: Food aid channels



Source: World Food Program- WFP 2012 Report http://www.wfp.org/fais/

(2) Project Food Aid/Targeted Food Aid is provided on a grant basis for hunger-related development, disaster relief, or nutritional programs**,** such as those for small children and pregnant and lactating mothers. Most project food aid is channeled through multilateral agencies like the WFP or through non-government organizations (NGOs).

The WFP believes that this is where it can obtain the best value for money in terms of compensation packages. It has greater value in terms of social stability and addresses many longer-term food security issues. Grant assistance is targeted at the poorest and hence those who need it most, including women and children. In 2004, according to WFP criteria, the volume of project food aid was 2.1 million tons, reaching 28 percent of those with hunger. Examples of project food aid include food for work (FFW) **and** food for training (FFT). In these activities, food is distributed to those who need it, so they can either participate in training or build community-based rural infrastructure that will help domestic output to meet their long-term food needs. In addition, school feeding programs attract children to attend school and keep them there, so they can learn while they are there. There is a proven strong link between education and food

security. Unlike program food aid, project food aid was originally focused on direct distribution to people **(**S. Murphy and K. McAfee, 2005; FAO, 2002).

(3) Emergency Food Aid is intended as the direct, free distribution of food to people facing famine or acute food shortages resulting from natural or manmade disasters.[72] While the overall food aid volumes have declined over the past 15 years, emergency food aid has increased as a proportion of total food aid (see Graph 1) (S. Murphy and K. McAfee, 2005).

Food aid is also categorized according to the way food is sourced: (1) Direct, (2) Triangular, and (3) Local. (1) **Direct transfers** are food aid donations that originate in the donor country. This mode of supply accounted for 74.5 percent of all food aid deliveries and 80 percent of food aid provided by the U.S. in 2003. All direct food aid transfers are a form of "tied aid" in the sense that they are limited by definition to food sourced in the donor country. **(2) Triangular transactions** characterize food aid purchased outside the donor country for use as food aid in another country. Such transactions accounted for 12 percent of all food aid in 2004. Of this food, 73 percent was purchased from developing countries. Triangular purchases are usually financed with a cash contribution from the donor for the initial purchase of the food. **(3) Local Purchases** refer to the procurement of food in the recipient country. About 15 percent of food aid was locally purchased in 2004. This is one of the most cost-effective ways to source food aid, although it remains just a small portion of total food aid contributions (S. Murphy and K. McAfee, 2005).

Food aid provides some immediate relief to countries with food security problems, but taking a longer-term perspective, most donors have been funding less food aid. Most aid policy analysts agree that local purchases or triangular purchases from nearby countries are generally preferable to direct food transfers. This is because food can be purchased more cheaply and shipping costs are generally lower from nearby sources. Moreover, when properly managed, food purchased locally or from other nearby developing countries can stimulate agriculture and other economic activities in hunger-prone regions (S. Murphy and K. McAfee, 2005).

Seeking to improve the effectiveness, efficiency, and quality of food assistance in preserving the lives and alleviating the suffering of the most vulnerable people, especially in emergency situations, as well as strengthening international cooperation and coordination, the food needs of developing countries were found to be in the interest of the 1999 Food Aid

[72] **Free distribution**- In 2005, WFP expects to need $1.1 billion for emergency operations, as well as another $1.3 billion for protracted relief and recovery operations.

Convention. Furthermore, it was recognized that while international strategies are important, states have the primary responsibility for fulfilling the right to food within their territories, including vulnerable populations with particular food and nutritional needs. This refers to the right to adequate food as set out by the Food and Agriculture Organization (FAO) in 2004.

The Food Aid Convention (FAC) is a set of voluntary guidelines for food aid that was first agreed in 1967 and later renewed in 1999 and 2002. The FAC has also been successively extended or renewed since then. This convention was established to foster a predictable flow of food aid. Donors commit to a minimum annual level of food aid for the duration of the FAC (usually three years), regardless of changes in price or supply. The convention spells out some useful goals for food aid, including prioritizing countries with the greatest need, something that is not a high priority in many bilateral food aid programs. Donors commit themselves to only use food aid where it will be the "most effective and appropriate" intervention. In 1999, the FAC adjusted its rules to allow donors to meet their obligations through cash for local or triangular purchases in addition to the usual in-kind donations. The FAC was due for further renewal in 2002, and the convention does some important standards that encourage donors to strive for better practices in development terms (S. Murphy and K. McAfee, 2005).

Some important issues that the 1999 Food Aid Convention deals with are:

- **Eligible recipients**, so food aid will be provided to the listed developing countries and territories, namely (a) the least developed countries, (b) low-income countries, (c) lower-middle-income countries, as well as other countries included in the WTO (world trade organization) list (FAO, 2002);
- **When food aid is needed,** so (a) food aid is only provided when it is the most effective and appropriate means of assistance and (b) food aid is based on a needs evaluation by the recipient with members paying attention to meeting the particular nutritional needs of women and children within their own respective policies (FAO, 2002);
- **Forms and terms of aid**, so food aid under the convention is supplied as (a) grants of food or cash for the purchase of food for the recipient country or (b) sales of food with payment to be made in reasonable annual amounts over periods of 20 years or more at favorable interest rates.

Food aid programs are not homogeneous in their forms and purposes, and they can be divided into three broad categories, as presented in Table 15 (T. O. Awokuse, 2011). Global food aid deliveries include all those made through multilateral, bilateral and NGO (Non-

governmental organization) channels. Table 16 gives the quantities of food aid actually delivered to recipient countries during the year under review and presents the five largest donors between 1988 and 2009.

Table 15: Government support for food security programs in developing countries

Targeting	Food	Income	Nutrition
Targeted	Emergency food aid	Cash transfer	Weaning foods for low-income families
	Food stamps for the poor	Unemployment benefits	
	School feeding for vulnerable groups	Pensions for the elderly	
Untargeted	General food-price subsidies	Universal child benefits	Water fluoridation
Self- targeted	Food-for-work projects	Cash-for-work projects	Iodization of salt
	Price subsidy for "poor foods"		

Source: own elaboration.

Table 16: Global food aid deliveries by size of donation (1988–2009)

Ranking	**1988**		**1990**		**1995**	
	Donor	**Tons**	**Donor**	**Tons**	**Donor**	**Tons**
1	US	8,173,768	US	7,598,658	US	4,004,717
2	European Community	1,701,475	European Community	2,233,661	European Community	2,708,883
3	Canada	1,208,648	Canada	918,673	Canada	479,419
4	Japan	518,745	Japan	475,575	Japan	849,126
5	Australia	338,217	Germany	351,200	Germany	235,358
Ranking	**2000**		**2005**		**2009**	
	Donor	**Tons**	**Donor**	**Tons**	**Donor**	**Tons**
1	US	6,670,437	US	3,824,270	US	3,099,953
2	European Community	1,024,796	European Community	648,516	Japan	387,130
3	Japan	522,908	China	495,713	European Community	297,526
4	Republic of Korea	351,703	Republic of Korea	493,221	Canada	285,484
5	Canada	306,776	UN	446,812	UN	261,273

Source: own elaboration based on World Food Program's International Food Aid Information System (INTERFAIS).

https://www.globalpolicy.org/images/pdfs/Global_Food_Aid_Deliveries_Largest_Donor.pdf

The overall performance and effectiveness of several decades of food aid programs have been scrutinized by different policymakers and food aid analysts (C. B. Barrett and D. G.

Maxwell, 2005; FAO, 2006). Since the inception of food aid programs, there has been an ongoing debate among analysts on the motivation of donors and the impact of food aid allocations on recipients. Some policymakers argue the virtues of food aid programs and contend that they have been effective in achieving their objectives. They point out the positive contributions that food aid has made in disaster relief and in helping several European and eastern Asian countries to improve their economies after major political and economic crises. In contrast, many other analysts argue that food aid has been ineffective and even produced dismal results. They argue that food aid programs have not fulfilled their promise of alleviating hunger and stimulating economic development in many Asian and sub-Saharan African nations (T. O. Awokuse, 2011).[73]

Between these two opposing views, however, there are some who recognize the positive contributions of food aid in reducing poverty and food insecurity but also advocate new and improved strategies for making food aid programs more effective in achieving their objectives (C. B. Barrett and D. G. Maxwell, 2005). The study of Lentz and Barrett (2008) explores several food aid policy regimes and demonstrates that improved targeting is the most important factor in determining food aid effectiveness (T. O. Awokuse, 2011).

Other critics of food aid contend that it potentially creates disincentive effects in recipient countries (T. W. Schultz, 1960; P. J. Isenman and H. W. Singer, 1977; S. Maxwell and H. W. Singer, 1979; J. Cathie, 1981). Another aspect of food aid projects can be found in its donors' interests, which are often motivated by both political and economic interests (R. C. Eggleston, 1987; S. Shapouri and M. Missiaen, 1990; E. Neumayer, 2005). For example, fewer food aid donations were available when they were most needed by countries facing chronic food deficits and expensive food imports. The data from recent decades for food aid allocation also show that the top recipients are not necessarily the neediest of countries with food deficits (C. B. Barrett and D. G. Maxwell, 2005: p. 9). In addition, the governments of recipient countries have been known to not distribute food aid to the most malnourished households, instead strengthening

[73]**Food aid programs have not fulfilled their promises**: For Jim Fitzpatrick and Andy Storey (1989), food aid inhibits local agricultural production in the recipient country, particularly by depressing local market prices. Furthermore, the availability of food aid may encourage a government to neglect its own agricultural sector in a policy disincentive. Abdulai et al. (2004) point out that rising food aid shipments to sub-Saharan Africa have negatively affected local agricultural development and therefore hindered poverty reduction. In addition, Bezuneh et al. (1988) and Barrett et al. (2001) found that food aid resulted in increased marketable surpluses, labor demand, and household savings among the participants of a food-for-work scheme in Kenya. Dorosh et al. (1995) and Barrett (2001) report very similar findings.

their political powerbases by “paying” people in food for their political support (T. O. Awokuse, 2011).

3.2.1.3 Sustainable agriculture

Recent approaches to agricultural production and food security have failed to reduce the prevalence of food insecurity or ensure environmental sustainability. However, the views on how to improve global food security vary greatly but tend to focus solely on increasing food production (J. N. Pretty et al., 1996).

In developed and developing countries, the general perception is that many agricultural practices degrade natural resources through soil erosion, water contamination, deforestation, desertification, and lost productivity (M. Dover and L. Talbot, 1987). Such evidence is mostly found in the developing countries of the tropics, where soils are commonly highly weathered, low in fertility, and susceptible to erosion (M. Dover and L. Talbot, 1987). Moreover, there is concern that increased yields using a high chemical input may not be sustainable over the long term for these soils (C. Francis et al., 1986). The concept of sustainable agriculture came in response to the degradation of natural resources, and it was first articulated by J. L. Jackson (1980) and by R. Rodale (1983). Early discussions emphasized the importance of maintaining the sustainability of agricultural ecosystems, claiming that many conventional agricultural practices were detrimental to renewal. This concept has been promoted and has evolved into a framework that puts forward the idea of more sustainable agriculture that integrates the principles of ecology and emphasizes the interactions among and within the biological components of agricultural ecosystems (C. A. Edwards et al., 1993).

In 1987, sustainable agriculture took on additional meaning. It described a global agriculture that could meet the needs of current and future generations while conserving natural resources (C. A. Edwards et al., 1993). Edwards (1987) provides a detailed definition of sustainable agriculture as “Integrated systems of agricultural production, with minimum dependence upon high inputs of energy, in the form of synthetic chemicals and cultivation, that substitute cultural and biological techniques for these inputs…” (C. A. Edwards et al, 1993).

Linking sustainable agriculture with food security is mainly appropriate for the rural poor in developing countries. In a way, it seems to fulfil the urgent need for an ecological revolution to succeed the agricultural and industrial revolutions, thus saving humanity and our planet, both of which are at a crossroads (A. A. D. Clarke, 2006). Several approaches and explanations favor

sustainable agriculture as a solution for the hunger problem. Linking food production and food security can be seen in the great efforts to predict the increases in agricultural production needed to achieve global food security over the next quarter to half a century. Most efforts were made by various organizations, such as IFPRI, the World Bank, and the FAO. These all conclude that food production will have to increase substantially over the next few decades to feed the increasing global population, and a sustainable intensification of agriculture offers significant opportunities for improving food production (J. N. Pretty, 2007; J. Thompson and F. Hinchcliffe ,1996; A. A. D. Clarke, 2006).

According to a report released by the FAO**,** the only way to eliminate world hunger and poverty is to make agriculture more environmentally sustainable (FAO, 2011). In this, the FAO points out that:

- climate change will triple the number of people struggling with food insecurity by 2030 if agriculture does not adapt to the new climate conditions; and
- the developing countries with the most vulnerable people may be exposed to more frequent droughts, floods, and other extreme weather events because of climate change (A. Weir Schechinger, 2016).

Moreover, as the EWG (Environmental Working Group) expressed recently in its *Feeding the World* report, agricultural practices like biotechnology and chemical fertilizers and pesticides, which are often employed by U.S. farmers, are not helping to feed those who suffer the most from undernourishment. The FAO agrees that these practices will not end world hunger, concluding that to feed those who are hungry now and prevent hunger from spreading, farmers must adopt sustainable practices that will help them adapt to climate change (A. Weir Schechinger, 2016). Conservation practices—such as crop diversification, drip or sprinkler irrigation, no-till farming, and growing more crops that are less reliant on nitrogen—are therefore key to adapting to climate change and addressing hunger. According to the report, adopting no-till farming alone could take almost 9 percent of people out of hunger by 2050 (A. Weir Schechinger, 2016) [74] .

IFAD (International Fund for Agricultural Development, 2013) echoes the notion that helping small farmers to adopt sustainable practices is crucial to reducing hunger and poverty

[74] **No-till farming** (also called zero tillage or direct drilling) is a way of growing crops or pasture from year to year without disturbing the soil through tillage. No-till farming is an agricultural technique that increases the amount of water that infiltrates into the soil and increases organic matter retention and cycling of nutrients in the soil. http://www.notill.org/

worldwide.[75] Combined with raising income levels, providing education for women and the poor, and improving infrastructure (e.g., easy access to markets), sustainable conservation practices can help farmers adapt to climate change and contribute to the eradication of hunger and poverty worldwide (IFAD, 2013).

For J. N. Pretty (1999), solving the hunger problem is not just a matter of developing new technologies or adopting sustainable practices that help deal with climate change. He claims that most hungry people are poorer farmers who cannot afford to invest in such expensive technologies, so it is necessary to develop solutions based on the available resources. This is where sustainable agriculture comes in by offering new opportunities for substantial increased food production in those regions that missed out in the past. Therefore, instead of relying on costly external inputs that only some farmers can afford, the improvements are based on improved configurations and better use of the natural, social, and human assets (J. N. Pretty, 1999). Sustainable agriculture therefore provides the opportunity to increase food production and reduce the dependency on external resources, all while minimizing environmental degradation (J. N. Pretty et al., 1996). Pretty et al. (2005) and Tilman (1999) also say that despite the fact that agricultural production gains have lifted millions out of poverty and provided a platform for rural and urban economic growth in many parts of the world, these advances in aggregate productivity have still not brought reductions in the incidence of hunger. In the early twenty-first century, more than 800 million people are still hungry and lacking adequate access to food. Furthermore, despite progress in food output, many agricultural practices are now believed to be a significant source of environmental harm (D. Tilman, 1999; J. N. Pretty et al., 2000; MEA, 2005; J. N. Pretty, 2007).

For Jules Pretty (1999), agriculture is fundamentally multifunctional, because it also delivers many unique nonfood functions that cannot be replicated by other economic sectors as efficiently. Thus, a key objective when reducing hunger is to find ways to enhance food production while seeking to both improve the positive functions and eliminate the negative ones. He also points out that past agricultural development has tended to ignore both the multifunctionality of agriculture and the external costs (J. Pretty, 1999).

[75] **IFAD** (The International Fund for Agricultural Development) is an international financial institution and a specialized agency of the United Nations dedicated to eradicating poverty and hunger in the rural areas of developing countries. https://www.ifad.org/web/guest/about

Sustainable farming makes the best use of nature for goods and services without damaging the environment (M. A. Altieri, 1995, 1999; L. A. Thrupp, 1996; Pretty, 1995, 1998). It does this by integrating natural processes—such as nutrient cycling, nitrogen fixation, soil regeneration, and the use of the natural enemies of pests—into the food-production processes. It minimizes the use of nonrenewable inputs (e.g., pesticides and fertilizers), which can damage the environment and/or be harmful to farmers and consumers. It also makes better use of the knowledge and skills of farmers, thus cultivating self-reliance and enhanced capacities. Sustainable agriculture is multifunctional within areas and economies. For example, it produces food and other goods for farmers to consume or sell at market, but it also contributes to a range of public services, such as clean water, abundant wildlife, carbon sequestration in soils, and flood protection (J. Pretty, 1999). The concept of agricultural sustainability does not mean ruling out any technologies or practices on ideological grounds. If a technology improves productivity for farmers without causing undue harm to the environment, then it is likely to have some sustainability benefits. Agricultural systems emphasizing these principles also tend to be multifunctional with respect to landscapes and economies (T. Dobbs & J. N. Pretty 2004; MEA, 2005).

Most of the agricultural sustainability improvements over the 1990s and early 2000s appear to have arisen despite existing national and institutional policies rather than because of them. Pretty (1999) emphasizes that sustainable agriculture systems also become more productive when human capital increases, particularly when farmers increase their capacity to actively manage and innovate their farming systems for sustainable outcomes. Moreover, sustainable agriculture is not a concretely defined set of technologies, nor is it a simple model or package that can be widely applied whatever the times. It is rather a process of social learning. A lack of information and poor management skills are major barriers to the adoption of sustainable agriculture. Bunch and Lopez (1996) put it as follows: "what needs to be made sustainable is the social process of innovation itself" (J. N. Pretty, 1999).

Although most countries support the idea of agricultural sustainability, the evidence points toward only patchy reforms.[76] These are often simply minor reforms of existing agricultural

[76] Few countries have given explicit national support for sustainable agriculture: Cuba has a national policy for alternative agriculture; Switzerland has three tiers of support to encourage environmental services from agriculture and rural development; and Bhutan has a national environmental policy coordinated across all sectors. Several countries have given sub-regional support to agricultural sustainability, such as the states of Santa Caterina, Parana´ and Rio Grande do Sul in southern Brazil in supporting no-till farming, as well as some states in India supporting participatory watershed and irrigation management. (Funes et al., 2002; Pretty, 2002; Herzog et al., 2005; Zhao et

policies (T. Dobbs & J. N. Pretty 2004; J. N. Pretty, 2007).[77] Sustainable agriculture was first adopted by smaller farmers, but following its proven success, several countries decided to operate sustainable agriculture practices on a larger scale, as well as introduce such practices as a national public-sector effort (J. Pretty and R. Hine, 2001; N. G. Roling, and M. A. E. Wagemakers, 2000). Since 1989, sustainable agriculture practices have been implemented in different developing countries of Asia and Africa, substantially increasing total farming productivity and making a significant impact on local and regional food security. Total production is an important measure, and sustainable agricultural systems are almost always more diverse and multifunctional than both the modern and pre-modern agricultural systems (J. N. Pretty, 1999).

A number of bodies are currently promoting sustainable agriculture in its various aspects. The most prominent of these organizations include the FAO, the Committee on Agriculture (COAG), and the National Sustainable Agriculture Coalition (NSAC). The NSAC was formed in 1994 with the aim of promoting healthy rural and urban communities, supporting small-to-medium-size family farms, and protecting natural resources (NSAC, 2016). COAG, meanwhile, was founded in 1971 and has played an important and influential role in helping to guide the FAO through a period of great development and change in global food systems. As the FAO's main technical advisory committee on agriculture, COAG has provided strategic policy and technical advice for many challenges. COAG is increasingly addressing the multiple dimensions of agriculture, making sure that its social, environmental, and economic dimensions are considered in FAO work and in its relation with member countries. Since the initial development of the Agenda 21 plan of action for sustainable development in Rio de Janeiro in 1992, the FAO has been leading its implementation in agriculture, with COAG contributing in a number of areas (United Nation, 2017).

In 2005, it was recognized by the FAO's member countries that sustainability is the key to successful agricultural and rural development. At the same time, COAG strongly backed the Sustainable Agriculture and Rural Development (SARD) initiative. In 2010**,** the committee fully

al., 2008). Such sustainable agricultural practices were implemented in 1989 by the Indonesian government (N. G. Roling, and M. A. E. Wagemakers, 2000).

[77] China's support for integrated ecological demonstration villages, Kenya's catchment approach to soil conservation, Indonesia's ban on pesticides and its program for farmer field schools, Bolivia's regional integration of agricultural and rural policies, Sweden's support for organic agriculture, Burkina Faso's land policy and Sri Lanka and the Philippines' stipulation that water users' groups be formed to manage irrigation systems. In Europe and North America, a number of agri-environmental schemes have been implemented over the past decade (Dobbs & Pretty, 2004).

endorsed the FAO's plan to support and contribute to the Rio+20 process and advise member countries on the preparatory process (United Nation, 2017).[78]

There are critics and advocates of sustainable agriculture programs. The critics point at negative elements, claiming that, for example, its methods result in lower crop yields and greater land use. Moreover, they say a wholesale commitment to its practices would mean inevitable food shortages for the world's population, which is expected to exceed 8 billion by 2030. In contrast, the advocates hold that sustainably farmed land can be as productive as its conventionally farmed counterpart. In other words, in the long run, there is no disadvantage to sustainable agriculture when compared to conventional methods (J. N. Pretty, 2007).

On the other hand, the study of Dixon et al. (2001) showed that agricultural sustainability was spreading to more farmers and land area in developing countries. These sustainable agroecosystems also have positive side effects, such as helping to build natural capital, strengthening communities (social capital), and developing human capacities (E. Ostrom, 1990; J. N. Pretty, 2003). Some examples of such positive side effects have recently been reported in various developing countries, as indicated by Pretty (2007). These include:

- improved natural capital, such as by increasing the water retention in soil and in the water level, thus providing more drinking water in the dry season, reducing soil erosion, improving the organic matter in soils, and increasing agrobiodiversity;
- improvements to social capital, including more stronger social organizations at the local level and better management of collective natural resources; and
- improvements in human capital, increased self-esteem in formerly marginalized groups (e.g., women), better child health and nutrition (especially in dry seasons), less migration, and greater local employment (J. N. Pretty, 2007).

[78] At the Rio+20 Conference, world leaders—along with thousands of participants from governments, the private sector, NGOs, and other groups—came together to shape how they could reduce poverty, advance social equity, and ensure environmental protection on an ever more crowded planet to get to the future everybody wants. https://sustainabledevelopment.un.org/rio20/preparatoryprocess

3.2.2 Multi-dimensional hunger-solution models

3.2.2.1 The Zero Hunger model

The Zero Hunger program is a Brazilian endeavor to reduce hunger in the country, and its considerable success has encouraged other developing countries to imitate this program. The underlying concept behind this program is based on the fact that Brazil's hunger problem is not caused by insufficient food production but rather people's lack of income to buy food in sufficient quantity and quality on an ongoing basis. The FAO's estimates show that Brazil has a per capita food availability that is equivalent to 2,960 kcal/day, much greater than the recommended minimum of 1,900 kcal/day. It therefore follows that food consumption must be limited by household incomes instead. Moreover, a high percentage of the population lacks sufficient access to food to even ensure survival, while there is a further segment of malnourished people consuming much less than the average of 1,650 kcal/day. There is an apparent paradox in that millions of families lack enough food in a country where food is plentiful, perhaps because of the extensive export of agricultural products (FAO, 2011).

The hunger problem in Brazil, much like other places, has been found to be difficult to tackle through compensatory policies based on traditional food donations alone, such as food parcels. Brazil has some structural problems, such as a lack of employment, low wages, and unequal income distribution, as well as food price hikes and a lack of agricultural policies. This situation was brought around by existing policies that were predominantly local in nature and based on transfers of small amounts of food that were insufficient to relieve the country's extreme poverty and undernutrition. Different programs have since been launched by the federal government, such as drought programs, the school grant program, child labor eradication programs, the income grant (Bolsa Renda) program, and the Food Grant program (FAO, 2011).

In January 2003, the Zero Hunger program (Fome Zero) was launched by the Brazilian Federal Government. President Luiz Inácio Lula da Silva requested support from the FAO (in setting up a technical expertise team), the Inter-American Development Bank (IDB), and the World Bank, so it could revise the design of its Zero Hunger initiative.

As a concept for fighting hunger in Brazil, the Zero Hunger Program aims to ensure food security for all Brazilian people, and this goes beyond ending the hunger problem. Its initial objective was to implement specific food and nutrition security actions and policies while coordinating with the social programs of other government bodies and civil institutions. Four

lines of actions were developed within this strategy: (1) access to food, (2) the strengthening of family farming, (3) income generation, and (4) social empowerment, mobilization, and oversight. Programs were also funded for three new actions: (a) the implementation of the Cartão Alimentação (Food Card) program to supplement the income of poor families, (b) the buying of food produced by family farmers (PAA), and (c) an improvement in the socioeconomic conditions of families, especially for minority groups and others in dire situations (FAO, 2009).

In 2005, the Zero Hunger (Fome Zero) program was described as a strategy of the Federal Government to ensure the basic human right to adequate food, giving priority to those facing most difficulty in accessing food. This initiative has an important element in its efforts to promote food and nutrition security and contribute to eradicating extreme poverty and hunger by ensuring food gets to those population segments that are more vulnerable to hunger.

In practical terms, the Fome Zero program comprises a set of over 30 complementary programs designed to fight the immediate and underlying causes of hunger and food insecurity. The federal government of Brazil supported these different programs with the aim of meeting its commitment to achieving the Millennium Development Goals. This related not just to the first goal of reducing hunger and poverty but also the further goals relating to education, health, the environment, and gender equality. The Ministry of Social Development and Hunger Combat (MDS) is the agency coordinating the Zero Hunger program.

According to the Zero Hunger project, the hunger problem in Brazil has **three fundamental dimensions**:

- an insufficient demand resulting from income concentration, high unemployment, and the weak purchasing power of most working-class people;
- a mismatch between the prevailing food prices and the weak purchasing power of most people; and
- the hunger experienced by poorer people who are priced out of the food market, including many unemployed, children, and other poorer groups in need of emergency assistance.

For these reasons, the Zero Hunger program involves **three main simultaneous actions**:

- expansion of the actual demand for food;
- measures to lower food prices; and
- emergency programs to assist the portion of the population excluded from the food market.

To eliminate hunger, Brazil also adopted a new economic development model in order to promote growth with better income distribution. This way, the domestic market could rebalance with job generation, higher wages, and an enhanced purchasing power for those on the minimum wage (FAO 2011). It was obvious to the Brazilian government that the fight against hunger could not wait for the eventual fruition of these structural policies, however, because it could take years and condemn many of those currently living with food insecurity. Therefore, the Brazilian government also simultaneously tackled the problem of hunger through short- and medium-term actions. In general, Zero Hunger's strategy combines two timetables: the short-term responses to emergency situations and medium- and long-term interventions that help foster the necessary conditions for families to guarantee their own food security. Something that stands out in this program is how it recognizes that people living in rural areas have needs that vary from those living in urban areas, so it offers different interventions in each case. Moreover, a central plank of this program is the participation of state and municipal governments, as well as civil society and the private sector. This multi-sector approach is certainly one of its strong points. Indeed, this has become a paradigm for what public policies can achieve with participation from civil society. Billions of US dollars were donated by anonymous individuals and corporations to the Fund to Combat and Eradicate Poverty, so the participation of non-governmental actors is clearly an important element in this program (FAO, 2009).

A key point of the Zero Hunger strategy is its broad, integrated strategy that guarantees access to food, food availability, and a nutritionally adequate diet from a sustainable perspective. Over 10 ministries are involved in this strategy (FAO, 2009).

The Zero Hunger strategy governs the relationship between the production, distribution, and consumption of food, and it includes three main dimensions:

- National level structural policies are coordinated by central or federal governments to address the primary causes of hunger and poverty. Among other things, this includes employment and income generation policies, the promotion of family farms, and agrarian reform.
- Specific national level food security policies ensure that all people can access the food they need for a healthy life. These include cash-transfer mechanisms, the distribution of food in emergency situations for a limited period, and the establishment of food stocks for

such distribution. Other specific policies touch upon food safety and quality, mother-and-child nutrition, and nutrition education.

- Local level policies are implemented through municipal or civil organizations with the objective of reducing the distance between producers and consumers. Such actions include peoples' restaurants, community kitchens, and food banks (Figure 6) (FAO, 2009).
- Other important actions are adjusted to the specific needs at the local level and encompass six interrelated components:
- a conditional cash-transfer program to immediately supplement the income of poor families, so they can buy the food they need;
- a stimulus program to help poor family farmers to increase their output;
- a health-and-nutrition program to support specific groups that need greater care (e.g., the elderly, children, nursing mothers, etc.);
- a program to monitor food intake;
- a comprehensive food-and-nutrition education program to promote the principles of healthy eating habits; and
- a food-supply-and-distribution program to ensure the low income population can access good quality food.

This food security policy does not focus solely on particular sectors, nor does it allow local actions to be taken in isolation from complementary actions at the regional and national levels, and these aspects were incorporated into national law (FAO, 2009).

As was mentioned above, the Zero Hunger strategy comprises 30 different programs, but we focus here on selected programs from four areas of intervention (Figure 5):

1. **Access to food,** which has seven elements:

- Cash transfers, from the Food Card to the Family Grant programs: The Food Card was the first cash-transfer program of Zero Hunger, giving an additional sum of money per month per capita to families on very low incomes (a monthly per capita income under US $25 and in extreme poverty), as well as other poorer households with children, elderly family members, and pregnant or nursing mothers.
- A Family Grant that initially assisted households living in poverty (a monthly per capita income of between US $24 and US $47) and in extreme poverty (a monthly per capita income below US $24). The Family Grant program was formulated to fight hunger and

poverty by (a) relieving immediate poverty through direct cash transfers to households and (b) strengthening basic social rights and improving access to health and education.[79]

- School Meals: The National School Meals Program (PNAE) provides assistance directly to public schools or their municipalities for all children attending public schools on a daily basis, so they will receive at least one meal per day. In addition, an important decision was made to source products locally from small farmers, thus helping to also boost local productivity and creating new markets for family farms.
- Access to Water, where cisterns are a central element for the inhabitants of the semi-arid region of Brazil: This involves storing water and guaranteeing potable drinking water for use during the dry season.
- Food, Nutrition, and Consumption Education: This program aims to encourage people to adopt healthier eating habits and subsequently stave off the illnesses associated with poor eating habits.
- Local Food Security Programs: Examples of these include (a) the creation of community-run restaurants that offer balanced, good quality meals at cost price and (b) the establishment of food banks by nonprofit organizations to distribute food considered unsuitable for sale but safe for consumption by poorer families.
- Meeting the specific needs of vulnerable populations: An example would be communities descended from slaves.

2. The strengthening of family farming: Rural areas are characterized by a high level of poverty and undernourishment, yet at the same time, family farms can potentially produce more food, so they play an important role in any food and nutrition security development strategy. This means that rural families would have access to sufficient, good quality food while also boosting their supply of food products to the general public (FAO, 2009). Two programs for this objective were applied: (a) The National Program to Strengthen Family Farming (PRONAF), which provides financial assistance to small-scale rural farmers and their families, and (b) the Food Acquisition

[79]**The Family Grant**: The findings of a study by the Brazilian Institute of Social and Economic Analysis (IBASE) on beneficiary families of the Family Grant showed that the cash transfer, together with the meals provided at schools, are the main means by which low-income households access food.

Program (PAA), which is a structural action of the Zero Hunger strategy aimed at directly linking local production with expanding food consumption (FAO, 2009).

3. Income generation: This includes programs that promote employment and better wages, broaden the availability of microcredit (enabling low-income people to access finance), improve access to quality education, and provide better housing and sanitation.

4. Social mobilization and oversight: In this ground-breaking area, the organization of society and the social participation of non-governmental actors plays an important part in the program (FAO, 2009).

The Zero Hunger strategy also articulates itself with other programs that contribute to promoting food security, namely by fighting hunger and poverty and promoting rural development. These include:

(a) the Territories of Citizenship program: a holistic approach that targets small cities and communities with low scores on the Human Development Index;

(b) Agrarian Reform to address the problem of access to land, which has always been a problem in Brazil, and ensure the social role of property in developing income-generating sources, as well as promote food production for subsistence purposes;

(c) A National Biodiesel Program that helps farming families with technical assistance, credit, and training, thus empowering them to produce raw materials for biodiesel plants; and

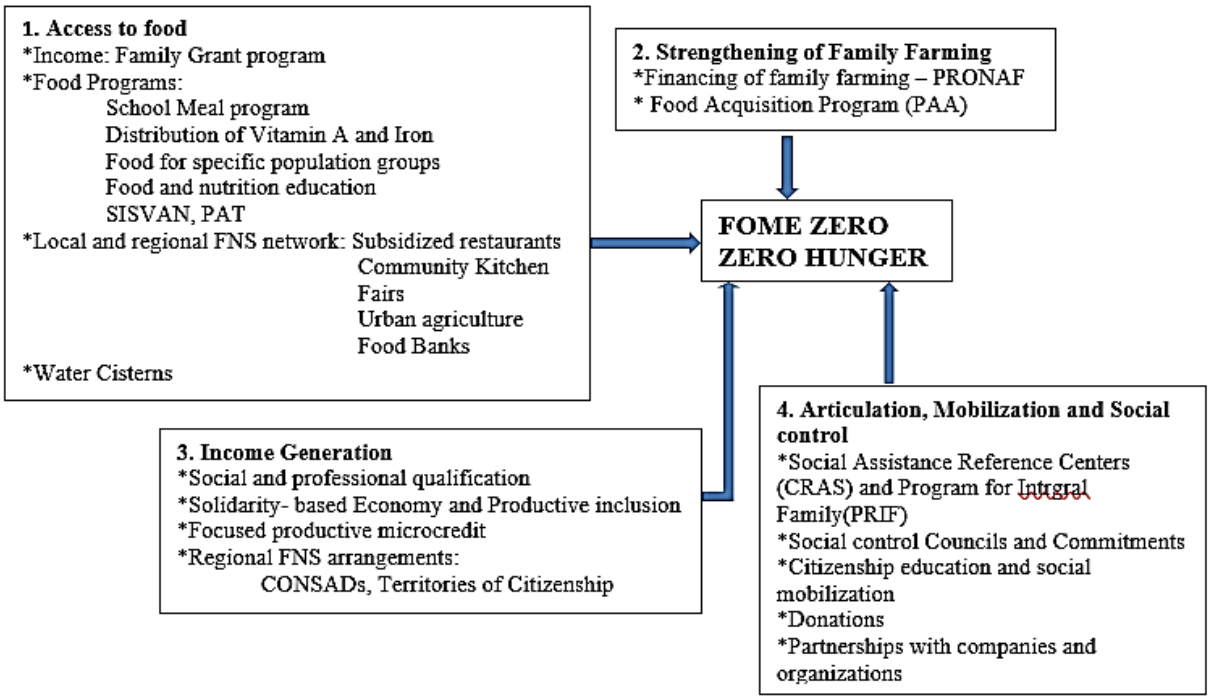
(d) The Rural Electrification "Light for All" program that provides poor households with a free electricity connection, thus ensuring universal access to electricity (FAO, 2009).

The Zero Hunger program has been a big success in fighting undernourishment and hunger in Brazil. [80] Despite this success, this program still has some work to do, particularly in the area of improving the efficiency, focus, impact, and sustainability of its sub-programs in future (FAO, 2011). There is also increasing evidence that the main components of the Zero Hunger program are beginning to generate economic benefits, so rather than considering it as a form of

[80]According to a report published by the Brazilian Presidency in 2007, the country has met the Millennium Development Goal set by the United Nations for 2015 of reducing extreme poverty by half. Brazil has also established a new target to reduce extreme poverty by a further 25 percent by 2010, putting the country on path to completely eradicating hunger and extreme poverty (FAO 2009). The 2016 GHI score for Brazil was at level 5 (GHI, 2016, http://ghi.ifpri.org/countries/BRA/).

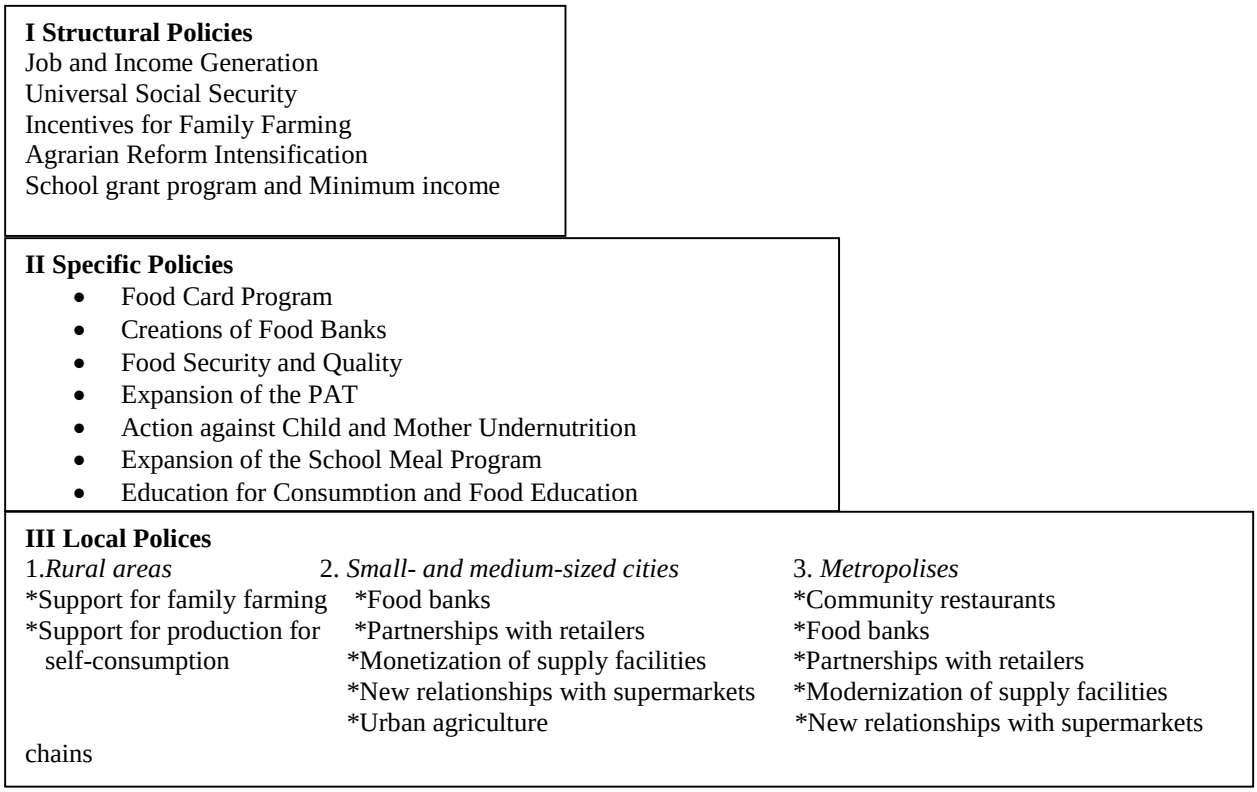
social protection, it is actually an investment. The cash transfers made under the Family Grant Program resulted not only in better nutrition, health, and productivity but also reduced families' susceptibility to shocks.

Figure 5: Zero Hunger programs and actions



Source: own elaboration based on (Aranha, 2010).

Figure 6: The Main dimensions of the Zero Hunger strategy



Source: own elaboration based on (Aranha, 2010).

The Zero Hunger program still raises many discussions in Brazil. Three topics under discussion are (a) the degree to which the conditional and social control of the program at the local level should be coupled with the cash transfers of the Family Grant program to ensure that the nutritional goals are also achieved; (b) the risk of creating long-term dependencies; and (c) the degree of emphasis on the underlying causes of hunger to secure short-term improvements in nutritional aspects.

Aside from its impact on Brazil, the program has affected many other countries, not just in Latin America but also in Africa and Asia. The Brazilian experience in reducing hunger has inspired other governments to follow the Brazilian example in designing, financing, and implementing a national food-security program. Indeed, the Zero Hunger program is a

multidimensional effort working on both economic and societal levels. A unique feature of this program is the important participation of non-governmental actors.

3.2.2.2 FAO food-security programs

The FAO have supported a variety of programs and measures to strengthen food security. Direct and indirect approaches have been used by the FAO to achieve food security. In the direct approach, the FAO sets the key principles to achieve food-security goals that participating countries need to comply with. The FAO's set of rules to achieve food security, with regard to the definition of food security, are based on the following four pillars: availability, access, stability, and utilization. The FAO's twin-track food-security program presents such an approach, and this will be discussed in this subsection. With the indirect concept, meanwhile, countries joining a program all formulate their own national food-security strategies within a framework provided by a special program. This program links the FAO's field activities around the program with the key objective of food security. The FAO's Special Program for Food Security (SPFS) takes such an approach, and this will also be discussed in this subsection.

3.2.2.2.1 The FAO's twin-track program

The goal of achieving food security for all is at the heart of the FAO's work. Food security was defined by the World Food Summit (1996) as meaning that "all people, at all times, should have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." This definition then divides the food security issue into four pillars. The first pillar concerns the physical availability of food, such as the production, distribution, and trade of food. The second pillar emphasizes the economic and physical access to food and covers the issues of poverty reduction and food prices, as well as access to natural resources and inputs that play an important role in food security. The third pillar concerns food utilization, which relates to the way the body uses the various nutrients in the food and involves suitable food quality and food safety. The fourth pillar relates to stability of the other three dimensions over time. To achieve food security, all four pillars must therefore be fulfilled simultaneously. The FAO therefore developed the twin-track approach as a conceptual framework to achieve this (FAO, 2011).

The FAO's twin-track approach for addressing food security involves enhancing agricultural productivity and promoting rural development while also facilitating direct access to

adequate, safe, and nutritious food for those in most need of it. The FAO also recognizes the relevance of good governance for increasing food security, eradicating poverty, and promoting sustainable development. Good governance for food security is underpinned by principles such as efficiency and effectiveness, responsiveness, accountability and transparency, participation, and equality (Table 17). These principles have the potential to ensure that food-security programs that follow the twin-track approach are effectively implemented. Good governance plays a crucial role in implementing environmental and agricultural policies that lead to increased food security and sustainable development for all. Effectively achieving food security requires stability, respect for the rule of law, administrative capacity, and a strong and capable civil society (FAO, 2011).

Table 17: The main good governance dimensions for food security

Dimensions	Description
Efficiency and effectiveness	Processes and institutions should produce results that meet the needs of society while making the best use of the resources at their disposal.
Equality and fairness	All groups, but particularly the most vulnerable, should have opportunities to improve or maintain their livelihood and wellbeing. The principle of equality requires that every person is equal before the law, irrespective of sex, age, race, color, religion, or any other factor.
Accountability	Accountability cannot be ensured without the rule of law and transparency.
Responsiveness	Institutions and processes should serve all stakeholders, including those of the most vulnerable and poor, within a reasonable timeframe.
Transparency	Timely and reliable information on the decisions and performance of all decision-making structures should be freely and easily accessible by the public. People must be informed about the decision-making processes and who is accountable and responsible for what.
Participation	All men and women should be able to determine their own well-being and participate in the planning, design, monitoring, and evaluation of the decisions affecting them. Individuals should be able to take part in the conduct of public affairs.

Source: Owen elaboration based on FAO 2011 [81]

The twin-track approach was first presented by the FAO in 2002 and later elaborated on in its proposal for the Anti-Hunger Program (FAO, 2003a). The twin-track approach builds upon

[81] **FAO (**2011) http://www.fao.org/fileadmin/templates/righttofood/documents/other_documents/2011_good_food_security_gov/FoodSecurityGovernanceWorkshop_backgroundpaper.pdf

the fact that hunger is both a result and a cause of poverty. Its two tracks are required to achieve quick successes in reducing hunger and poverty. The first track creates opportunities for the hungry to improve their livelihoods by promoting development, particularly agricultural and rural development, which is achieved through policy reforms and investments in agriculture. The other track involves direct and immediate action to combat hunger. This begins with programs that enhance hungry people's immediate access to food, thus increasing their productive potential and allowing them to benefit from development opportunities (Table 18). This direct, immediate action is required to help the hungry, because they simply cannot wait for economic growth to have a significant impact on food availability (H. de Haen & G. Hemrich, 2006).

As outlined in Table 18, the first track addresses measures for establishing resilient food systems. Factors that affect this resilience include the structure of the food economy as a whole and its various components, such as agricultural production, technology, the diversification of food processing, markets, and consumption. The second track, meanwhile, assesses the options for providing support to vulnerable groups. A vulnerability analysis offers a forward-looking way of understanding the food-security dynamics by drawing explicit attention to the risks and the options for managing them. The two tracks are intended to be mutually reinforcing, and the positive interaction between them should reinforce the path to recovery.[82] A range of options are available for addressing long-term food security through sustainable agricultural and rural development aimed at preventing or mitigating risk (FAO, 2006)**.** Hartwig de Haen and Günter Hemrich point out that most countries that are successful in reducing poverty have indeed followed such twin-track strategies (H. de Haen and G. Hemrich, 2006).

[82] For example, managing risks goes beyond assisting those affected by a particular shock when addressing the immediate food needs.

Table 18: The twin-track approach to food security

Track	Availability	Access	Stability	Utilization
Track One Rural development and productivity enhancement	*Improving productivity and production capacity, esp. of low income farmers *Investing in infrastructure *Improving the functioning of input and output markets	*Promoting income-earning opportunities *Enhancing access to assets *Facilitating the creation of rural enterprises *Improving the functioning of rural financial systems and labor markets	*Facilitating diversification *Reducing production variability (irrigation, water harvesting, pest control etc.) *Monitoring production and consumption shortfalls *Improving access to credit and saving services	*Food handling and storage infrastructure *Food safety regulation and institutions *Safe drinking water and sanitation
Track Two Direct and Immediate Access to Food	Food aid *Market information *Transport and communication	*Cash transfers School meals *Food for work programs *Community and extended family structures	*Safety nets	*Nutrition intervention, health and education programs

Sources: FAO (2003 c) and H. de Haen and G. Hemrich (2006)

Hartwig de Haen and Günter Hemrich (2006) propose that in disaster-prone locations, measures to improve disaster resilience should be an integral part of food security policies and strategies. They present an expansion of the twin-track approach to hunger reduction to a triple-track approach that gives attention to cross-cutting disaster risk management measures. They point out that some of the areas requiring more attention include risk information and analysis, land-use planning; upgrade of physical infrastructures, diversification, and risk-transfer mechanisms. This of course depends upon the specific circumstances, so any measures under the two tracks for countries that are vulnerable to natural disasters must be focused on their particular needs to ensure food security. According to this concept, the twin-track approach needed a third track to be added. This third track presents measures that address the effects of disasters on vulnerable people and their assets in order to foster a greater resilience against the natural factors that cause disasters. This needs to be applied to all four elements of food security, namely availability, access, stability, and utilization (Table 19) (H. de Haen and G. Hemrich, 2006).

Table 19: The expanded twin-track approach

Track	Availability, Access, Stability, and Utilization
Track 3 Building greater resilience against natural disasters	*Risk information, analysis, and early-warning legislation *Settlement and land-use planning *Upgrade of physical infrastructure *Diversification *Risk-transfer mechanisms (e.g., insurance and capital markets) *Improving the transition and sequencing of emergency rehabilitation-development efforts

Sources: Based on H. de Haen and G. Hemrich, 2006

3.2.2.2.2 FAO's Special Program for Food Security (SPFS)

The SPFS program was first presented in 1994 and later endorsed at the 1996 World Food Summit, where delegates called for a halving in the number of malnourished people in the world by 2015 (E. E. Dooley, 2004). The motivation for this program was the FAO's study, which points out that the main challenge to food security is a growing population, especially in developing countries, with the world's population expected to rise from 5.7 to 8.3 billion by 2025. Such growth will worsen food-security problems, especially in developing countries, unless well-targeted actions are taken to improve food security. The FAO study also points out that chronic undernutrition and food insecurity principally results from (a) low productivity in agriculture frequently caused by unsuitable policies and institutional and technological constraints; (b) seasonal influences on food supplies, often due to unreliable rainfall and insufficient water for crops and livestock production; and (c) a lack of off-farm employment opportunities, contributing to the problem of low and uncertain incomes in rural areas (FAO, 2011). The FAO's Special Program for Food Security (SPFS) therefore aims to improve nations' food security through rapid increases in food production and productivity, reductions in the year-to-year variability in food production, and improvements in people's access to food. (E. E. Dooley, 2004).

The SPFS uses a two-phase approach in its new food-management model. The first phase provides farmers and others involved in the project with the basic essentials seeds and farming implements together with training in best practices. Each project has four components: water control; the intensification of crop-production systems; the diversification of production systems;

and the analysis and resolution of obstacles. In the second phase, successful approaches are scaled up, and the SPFS works at the national level with member countries to create a nationwide strategy for food security (E. E. Dooley, 2004).

A unique leading concept in the SPFS program is its special program management. The SPFS program is implemented by countries that choose to adopt its principles. These countries receive technical and financial support from the FAO and other international and national sources, but each government is responsible for the actual design and implementation of their own programs.

Agriculture plays a critical role in this program, since the most effective way to strengthen food security and improve the lives of the poor is by helping the agricultural sector. Increased agricultural production can raise the incomes of farmers, as well as agricultural workers, providing them with the funds to purchase agricultural inputs, services, and consumer goods. This, in turn, increases the employment opportunities in rural areas and helps slow down the migration to urban centers. In addition, this program promotes the use of proven technologies such as those to improve crop varieties and low-cost irrigation and drainage systems.

The core features of the SPFS include raising farmers' net incomes, generating rural employment, and increasing social equity. More specific actions include (a) improving farmers' technologies and management practices; (b) disseminating successful farming methods among smallholders; (c) reforming policy to remove bureaucratic constraints and create conditions conducive for increased food production, higher farm incomes, and greater off-farm employment (FAO, 2011). Table 20 summarizes the SPFS key principles, presenting five leading subjects. This special program has been designed to target the low-income, food-deficit countries (LIFDCs), where most of the world's 800 million chronically undernourished people live.[83]

[83] **Low-income, food-deficit countries (LIFDCs):**-The list was developed by the FAO in the late 1970s to assist in analyzing and discussing food security issues. LIFDCs are currently defined as nations that are poor with a net income per person that falls below the level used by the World Bank to determine eligibility for IDA assistance. At present, this means that their net income amounts to less than US$1,395 per person. They are net importers of food, with imports of basic foodstuffs outweighing exports over the past three years. In many cases, particularly in Africa, these countries cannot produce enough food to meet their all their needs and lack sufficient foreign exchange to fill the gap by purchasing food on the international market. http://www.fao.org/focus/e/SpeclPr/LIFDCs.htm

Table 20: The SPFS's key principles

Key principle	Description
National ownership	Participating countries' governments are responsible for the program's success. This depends on the willingness of governments to establish a political, social, and economic climate conducive to agricultural growth. This means adopting appropriate policies and regulations, providing training, extending information services, and investing in research, roads, and irrigation.
Focus on areas and foods with high potential	Areas known to have good possibilities for increased productivity will be targeted. Priority will be given to increasing the production of staple food crops that represent the foundation for food security and an adequate diet.
Participatory philosophy	Typical participants will be the government officials of both recipient and donor countries, scientists, extension workers, private traders and entrepreneurs, experts from intergovernmental agencies and NGOs, and the farmers themselves. In addition, considerable care will be taken to avoid excluding any social group or creating inequalities.
Environmental awareness	Natural resources, as well as biological diversity and the existing ecosystem, will be protected by finding and promoting new techniques that do not harm the environment, as well as by reducing pressure on marginal areas with low potential, which are often ecologically vulnerable.
Regard for the role of women	Particular attention will be paid to involve women, whose important role in food-crop production in the LIFDCs as farmers and agricultural workers has frequently been overlooked in the past.

Source: Own elaboration

This food-security program was launched by the FAO in 1994 and endorsed by the World Food Summit (WFS) in November 1996. It has already made a substantial contribution to the summit's goal of halving the number of chronically undernourished people in the developing world. The Global Agriculture & Food Security Study of 2014 pointed out that each country using this program experienced increased food security, higher rural incomes, and reduced poverty. Countries that sign up to participate in this program all formulate their own national food-security strategies within the framework provided by the special program. The first pilot of the special program showed significant yield increases, offering grounds for hope (FAO, 2011). Further trials

and the development new policies, as well as the program's expansion, are being carried out by the FAO (FAO, 2011; FAO, 2014).

Conclusions

Possible solutions to the hunger problem include different concepts, some are food-based approaches, other based on wider concepts to address this issue. Behind these efforts standing one of the leading organization on hunger, the FAO. The FAO declaration in the seventies was: "to ensure humanity's freedom from hunger." Over the years, various bodies were established to achieve world food security in the developing countries. FAO, proposed the establishment of a World Food Board as an international means to achieve world food security by addressing the issues of nutrition, health, agriculture, trade, and industry.

FAO adopted different approach to reduce hunger level and this organization launched the worldwide Freedom from Hunger Campaign. It was, to raise public awareness through education and information about hunger. FAO leading food aid not just as a way to meet food-shortage emergencies disasters cases, but also as a means to advance economic and social development in developing countries. This resulted in the establishment of the World Food Program.

During the nineties, a series of international conferences mostly related to world food security resolutions, leads to a series of commitments, ended with the Millennium Summit at the United Nations in 2000. Where, world leaders agreed to specific millennium development goals and targets, including halving the proportion of the world's population suffering from hunger. This was an important turning point in understanding hunger as a global issue rather than a local phenomenon.

The various dimensions of hunger have attracted different solutions from organizations, agencies, and governments, resulting in numerous approaches to eradicate hunger. Two basic approaches can be distinguished in those hunger solutions. The first is based on the assumption that food deficiency is the main reason to cause hunger in developing countries. The second approach, is based on the assumption that world hunger is about the inability to get food to those who need it. This work refers to the first approach as a one-dimensional hunger-solution model. This huger model emphasizes that this solution focusses on one channel of activity to eradicate hunger. The second concept is considered as a multi-dimensional hunger-solution model. Such

model seems hunger as a complex, multi-dimensional problem that requires a multi-pronged solution. In this case it is needed to work simultaneously on several channels of activities related to hunger. These two categories followed by six examples.

On the one-dimensional hunger solution model considered to be: ●Food subsidies- its basic working plan consist of five major subsidies all concerning to agriculture activity such as: support subsidies on agricultural output; agricultural mechanization services; subsidization of fertilizers and others. ●Food Aid- works on two channels of food aid: The ways food aid contributes to food security and the ways the food aid is sourced. ●Sustainable Agriculture- focus mainly on increasing food production. While linking sustainable agriculture with food security. Its strategic and policy addressing different agriculture's issues: of its social, environmental and economic dimensions.

On the multi-dimensional hunger-solution model: ●Zero Hunger model- emphasizes its multi-strategy simultaneous action on: access to food; strengthening of family farming; income generation; social empowerment. ●FAO's twin-track program- The core elements of this program include: rural development and productivity enhancement; promoting income earning opportunities; as well as it leads good governance concept. ●FAO's Special Program for Food Security (SPFS)- this hunger model working plan has different activities such as: adopting new policies and regulations; providing training, information services; increasing the production of staple food; protecting natural resources as well biological diversity.

So far, it is not clear what is the decision making basis to prefer implementation of one program or another.

Chapter 4: The hunger-management model concept

The different hunger solutions introduced in the previous chapter actually offer a package of hunger-fighting measures that form the means for addressing the hunger issue. An important striking distinction about countries' behavior when applying such solutions is how countries do not usually implement the original program in all of its different facets. Moreover, less developed countries (i.e., typically those with a more severe hunger problem) generally apply a lower number of criteria to address their hunger problems than more developed countries with a less severe hunger problem. This disparity prompted the idea to find a new concept for fighting hunger, as introduced in this chapter. This new concept for a "*hunger-management model"* is based on this distinction, so it defines two different hunger-fighting approaches: the low use of criteria and the high use of criteria in a *hunger-management model*.

4.1 Types of hunger policy

The way the hunger problem is framed in the research literature actually influences the kinds of solutions being offering by different organizations and agencies. The types of hunger policy indicate the various types of programs that are implemented to address the hunger issue in various developing countries. The fight against hunger in developing countries requires the drafting and implementation of suitable policies that mostly promote food security and nutritional objectives but also other related issues.

The common conception of hunger is as a problem caused by a lack of food, and to address this, various policies are used by organizations engaged in fighting hunger in developing countries. As mentioned before, food security policies are leading concepts for solving the hunger problem. They focus on finding ways to enlarge food production, as well as addressing various challenges in agricultural systems.

The research literature introduces several policy types. Four leading organizations that are deeply involved in reducing hunger have developed four basic policies to address the hunger problem in developing countries:

i. **The European Union (EU):** The EU's leading food security policy is a food-systems approach combined with an integrated approach that emphasizes that food security is not a standalone problem.

ii. **The Food and Agriculture Organization (FAO):** The FAO's leading rural-development policy integrates the agricultural and non-agricultural aspects of rural life. It is concerned with economic and social objectives to provide rural societies with a more secure livelihood.

iii. **The Hunger Project (HP):** The HP's leading policy takes an innovative holistic approach that empowers women and men living in rural villages.

iv. **The World Food Program (WFP):** The WFP's leading policy focuses on strengthening individual and government capacity in various fields.

The following text introduces each of these policies in greater detail, pointing out that some policies apply similar criteria when addressing the hunger problem in developing countries.

4.1.1 The EU's framework policy

The EU's leading food security policy is divided over four main areas: (i) rural development and food aid actions; (ii) investment in modern agriculture and multilateral agreements; (iii) genetically modified foods; and (iv) an integrated approach.

Rural development and food aid actions

This initiative addresses food availability in developing countries. The EU is one of the world's leading economies, and it has made a great contribution to improving FNS (Food and Nutrition Security) in the world. The EU's policy framework highlights that food security strategies need to be "country-owned and country-specific" and that each country should seek "an appropriate balance between support to national production and covering food needs through trade" (A. Maggio et al., 2015, p.23). The EU is also involved in development aid interventions, focusing on areas such as small-scale food production in developing countries to increase the availability of food, support for social protection, greater nutrition action at the country level, and priority for vulnerable countries (A. Maggio et al., 2015).

Investment in modern agriculture and multilateral agreements

The EU emphasizes that food insecurity is not just about a country's inability to feed its people. Diverse driving forces affect food security, such as population growth, limited water resources, and climate change. These have all been found to have some impact on food production levels and consequently food insecurity, so serious investment is needed in modern agriculture. In addition, due to the globalized nature of the 21st century, food security is no longer a local problem—it crosses borders, so it needs multilateral agreements and actions to achieve an effective solution. Therefore, both political action and sufficient investment in modern agriculture are needed to address hunger in developing countries (J. Premanandh, 2011).

Genetically modified food (GMF)

GMFs are proposed as one tool to relieve world hunger. Such biotechnological techniques could be considered a means to solve many of the malnourishment and hunger problems in developing countries. Biotechnological advancement is a significant approach to meeting the demand for more food, and it could relieve malnutrition in certain parts of the world (Pingali, 2012). In practice, populations that have increased their food production through the use of transgenic foods have experienced significant reductions in their levels of poverty and hunger (J. T. Medialdea et al., 2018).

An integrated approach

This approach is based on the notion that food insecurity is not a one-dimensional issue, so any solution needs to combine different elements that could be key to achieving sustainable food security. S. N. Nooghabi et al. (2018) point out that food security is not just about producing more food—the environmental and social costs that come with greater food production must also be considered. Achieving food security therefore requires more than a stand-alone solution—it needs to integrate different approaches, such as organic farming and GM (genetically modified) crops, as well as increased investment, policy reforms, and the development of human capital (S.N Nooghabi et al., 2018).

4.1.2 The FAO's rural development policy

This policy pays attention to the livelihoods of farmers and their families. It emphasis that rural-development programs and projects are formulated with particular reference to agriculture, because this is the basis for the livelihood of most rural families. The vast majority of people in developing countries live in rural areas and gain sustenance from agriculture in its various form. Many of these people are very poor and dependent on agricultural practices without modern technology. The FAO finds it very important to give a high priority to rural development. What is more, agriculture is a vital part of many developing countries' economies, being critical to the development of the national economy as a whole.

A rural development policy includes the agricultural and non-agricultural aspects of rural life. Rural development is therefore concerned with transforming the social and economic structures, institutions, relationships, and processes in rural areas. Its basic notion is that rural development is not just about agricultural and economic growth but also balanced socio-economic development. The rural-development process therefore includes economic and social objectives. Such programs seek to transform rural societies and provide a better and more secure livelihood for their people. In other words, the problems that rural development programs attempt to solve come not just from the agricultural side but also include the social, as well as institutional, problems found in rural areas. These problems can be divided into two groups:

i. **Physical problems:** These problems relate to the physical environment of a particular rural area, such as a lack of water, poor infrastructure, inadequate health facilities, and soil erosion.
ii. **Non-physical:** These problems relate more to the social and political conditions of the region that farmers live in, such as limited access to land, no contact with government services, and dependence upon bigger farmers.

Rural development programs implement the following principles:

i. **Access:** This ensures that the program and its benefits reach those who need it.
ii. **Independence**: While the program supports farmers, it also ultimately makes their livelihoods independent of the program.

iii. **Sustainability:** This ensures that the program's plans and solutions are relevant for, and adapted to, the local economic and social conditions, as well as the administrative situation.

iv. **Going forward:** The technological aspects of rural-development programs prefer to make modest advances that fit with the abilities of most farmers, so they can be sustained.

v. **Participation**: This involves local farmers in different aspects of the program.

vi. **Effectiveness:** The program is based on the effective use of local resources. The effective use of resources, something that is within the capabilities of most farmers, can have a substantial and broad impact.

On the practical side, rural development strategies implement various projects in rural areas:

i. Government and non-government assistance to rural areas through maternal and child health programs;

ii. Specialized staff to supply expertise for promoting rural development programs, such as experts in fields like agriculture, healthcare, or water sourcing;

iii. Financial resources and institutional budgets to provide the necessary financial support; and

iv. External aid channeled through various rural development programs (FAO, 1997).

4.1.3 The Hunger Project (HP)

HP programs are based on an innovative, holistic approach. They highlight how hunger is not merely about food but also about transformation. Such programs focus on challenging the traditional ways of thinking that have allowed hunger and poverty to persist. They emphasize the importance of empowering the women and men living in rural villages to become agents of their own development, thus bringing sustainable progress in reducing hunger and poverty. There are three pillars to this approach: (1) empowering women as key agents of change; (2) mobilizing entire communities for self-reliant action; and (3) promoting effective partnerships with local government.

What is more, HP programs focus on the following basic principles:

i. **Human Dignity:** HP applies the concept of equal dignity and rights for food, health, work, and education. Every person is creative, resourceful, self-reliant, responsible, and productive, and people should not live in a condition of hunger, which could devastate their dignity, but rather be regarded as a key resource for ending hunger.
ii. **Gender Equality:** Society should shift toward gender equality. Women are frequently responsible for meeting basic needs, yet they are denied resources, freedom to act, and a voice in the decision-making process to fulfill that responsibility.
iii. **Empowerment**: Action is needed to promote self-reliance and build confidence, as well as encourage communities to take charge of their own development.
iv. **Leverage**: Actions are needed to catalyze large-scale systemic change, thus evolving social, political, economic, and environmental actions.
v. **Sustainability:** Solutions to end hunger must be sustainable locally, socially, economically, and environmentally.
vi. **Social Transformation:** This is a fundamental shift in the way society is organized, such as by addressing corruption, armed conflict, racism, and the subjugation of women.
vii. **Holistic Approach:** A sustainable basis is given by improving the availability of decent work, health, education, environmental sustainability, and social justice.
viii. **Transformative Leadership:** A new kind of leadership is needed to motivate people to exploit their own power, namely a leadership "with" the people rather than "over" the people (The Global Hunger Project, 2018).

4.1.4 The World Food Program (WFP)

The WFP offers nationally tailored technical assistance and capacity development to strengthen individual and government capacities in many different fields. This program emphasizes strengthening the national capacity for achieving food security and nutrition. The WFP's program works through various policies, placing priority on nutrition as a core element of the program. This approach integrates with initiatives to prevent the direct causes of malnutrition and hunger, with the majority of efforts targeting the most vulnerable, such as young children, pregnant women, breastfeeding mothers, and people living with HIV (Human Immunodeficiency Virus). The WFP also works to improve the ability of countries to find long-term solutions.

To achieve appropriate sustainable food security and nutritional solutions, the WFP focuses on the following objectives:

i. **Climate action:** This is for disaster risk reduction**.** Through different programs, innovations, policies, and technical support, the WFP helps those most at risk to become climate resilient and food secure.

ii. **Gender equality:** Women, men, girls, and boys should all enjoy equal access to food and nutrition, resources, rights, and opportunities. The WFP promotes gender equality by providing food assistance to bridge the gender gap. Implemented initiatives include school meals, support for smallholder farmers, health, nutrition, and protection programs, all of which boost access to food and/or improve livelihoods.

iii. **Nutrition:** The WFP works with governments and other partners to help vulnerable groups—such as women, children, and people receiving treatment for HIV and tuberculosis—gain access to a nutritious diet. This includes distributing specialized nutritious foods and providing school meals.

iv. **Smallholder market support**: Smallholder farmers are highly vulnerable to hunger, so the WFP helps develop sustainable food systems that include smallholder farmers along the value chain. This includes buying their produce for WFP programs, introducing them to formal markets, and helping them to access the skills, knowledge and infrastructure needed to develop their livelihoods and reduce their risks.

v. **Social protection and safety nets**: The poorest are always most vulnerable to hunger and poverty, so the WFP supports national governments in designing social protection programs and safety nets, such as school feeding programs.

vi. **Sustainable livelihoods and ecosystems:** The WFP's special programs give vulnerable communities food or cash-based transfers while they build up or restore assets to increase their resilience, enabling them to become food-secure in the long term.

vii. **Nutrition and HIV/AIDS programs**: In the area of HIV and TB (tuberculosis), the WFP works directly with governments and other national actors to support the development of strategies for providing food and nutrition security to people living with these conditions (WFP, 2018).

4.2 Hunger-management models

The *hunger-management model* introduced in this study is a new tool, as well as a concept to address the hunger problem in developing countries in a more effective way. In fact, this study builds on the original hunger-management model (i.e., food scheme) that comprises an effective combination of existing solutions for countries at different development levels. Our *hunger-management model* is based on two different hunger-fighting approaches: the low use of criteria and the high use of criteria in the hunger-management model. By criteria, this study refers to the means for addressing the hunger issue, and this could include encouraging farming, providing school meals, implementing food waste programs, supplying food aid, and so on. This section presents the following two concepts: *hunger criteria* and the *hunger-management model.* Two leading points of interest are therefore involved in fighting hunger in developing countries*:* (i) a developing country's performance in various areas and (ii) the number of applied criteria.

4.2.1 Hunger criteria

The four leading organizations that are very active in reducing hunger (the EU, FAO, HP, and WFP, as presented in section 4.1) apply four basic policies to promote their fight against hunger in developing countries. Each policy employs several criteria that work on different fields of action, such as agriculture or social areas. These criteria include encouraging smallholder farmers, providing food aid or cash for purchasing food, supplying school meals, implementing food waste programs, increasing the knowledge and skills of farmers in different areas, implementing agriculture-development programs, and setting up food banks. Table 21 shows seven hunger criteria that are used by different leading organizations in their hunger-fighting programs for developing countries.

Table 21: Different hunger criteria used by countries in their fight against hunger

Country	**Hunger program**	**Encouraging farming/ smallholder farmers**	**School meals**	**Food waste program**	**Food aid/ cash for perching food**	**Knowledge**	**Agriculture-development program**	**Food banks**
Angola	WFP food security	**x**	**x**	**x**	**x**	**x**	**x**	
Bangladesh	Hunger Project	x	x		x	x	x	x
Benin	Food security	x	x			x		x
Bhutan	WFP	x	x				x	
Bolivia	Zero Malnutrition Program	x	x		x	x	**x**	
Botswana	Food and Nutrition Security(FNS)	x	x				x	
Brazil	Zero Hunger Program	x	x		x	x	x	x
Cambodia	WFP food security	x			x	x	x	
Cameroon	WFP Food Security	x	x		x	x	**x**	
Colombia	WFP Food security	x	x				**x**	
Cuba	WFP Food security	x			x		**x**	
Dominican Republic	WFP Food security	x				x	x	
Eritrea	Food insecurity	x				x	x	
Ethiopia	WFP Food Security	x	x		x		x	x
Fiji	Food security	x			x		x	
Gabon	Developing agricultural	x					x	
Ghana	WFP Food security	x	x		x	x	x .	
Kenya	WFP Food security	x	x		x	x		
Liberia	WFP Food security	x.	x		x		x	
Malawi	WFP Food security	x	x		x			
Malaysia	WFP Food security	x		x	x			
Mali	WFP Food security.	x	x		x		x	
Mongolia	WFP Food security	**x**			x	x	x	
Namibia	WFP Zero hunger	**x**	x		x	x		
Nepal	WFP Food security	x	x		x	x	x	
Nicaragua	WFP Food security	x	x		x		x	
Niger	WFP Food security	x	x		x	x	x	
Nigeria	WFP Food security	x			x	x	x	

Source: Own elaboration

Hunger in the research literature is mostly linked with the concept of food security. However, addressing the hunger problem is about strengthening the populations of developing countries, mainly by focusing on their rural societies from a social and economic viewpoint

(CONCORD,[84] 2017). Smallholders can play an important role in fighting hunger when provided with incentives and support from government, thus helping to achieve national food security and rapidly reducing hunger. Countries like China, Ghana, and Brazil have shown that promoting agricultural growth is critical for addressing their hunger problems. Helping farmers increases incomes and reduces poverty and hunger, so selected agricultural criteria can have a significant impact on reducing poverty and hunger (M. Curtis, 2011).

A large number of poor and powerless people suffer under policies that perpetuate their poverty. There is a need to formulate the right kind of policies and state interventions to suit the circumstances of a particular country. Reducing hunger and boosting economic development connect with agricultural growth, where growth in the rural economy helps both the rural poor and the overall economy (M. Curtis, 2011).

As shown in Table 21, agricultural development, in its various criteria, is the main tool for fighting hunger. In other words, most of the countries in this study's sample applied agriculture criteria such as encouraging farming and supporting smallholders, implementing agricultural development programs, and applying food waste programs (in some countries).

Over 15 criteria for fighting hunger in developing countries have been suggested by different organizations. Subsets of these criteria have been implemented by different developing countries to tackle the root causes of hunger and achieve the first Millennium Development Goal (see Table 11).[85] The criteria are selected based on the environmental, financial, and social aspects that need to be addressed in a developing country with an ongoing hunger problem (Table 22).

[84] **CONCORD** is the Confederation for Relief and Development, representing 2,600 NGOs (Non-governmental organizations)**.** https://guides.lib.umich.edu/c.php?g=282816&p=1884493

[85] Millennium Development Goal 1: Eradicate Extreme Poverty and Hunger.

Table 22: Several criteria identified in terms of agricultural, economic, and social aspects

Social	Economic	Agricultural
Food aid actions	Multilateral agreements	Rural development
Gender equality	Financial resources	Genetically modified foods
Society empowerment	External aid	Investments in modern agriculture
Social transformation	Smallholder market support	Climate action
HIV/AIDS programs		Food waste program
Social protection		
Food banks		
School meals		
Food for work		

Source: Own elaboration

Decision-makers, whether government or other stakeholders, select which policies and criteria should be applied. Such policy packages are vital for a developing country fighting hunger (K. Hansson et al., 2011)**.** Different policy packages are represented by various FAO programs:

i. The **Zero Hunger program** presents a broad policy package with an integrated strategy to fight hunger. This program implements four basic criteria: access to food, the strengthening of family farming, income generation, and social empowerment (FAO, 2011).

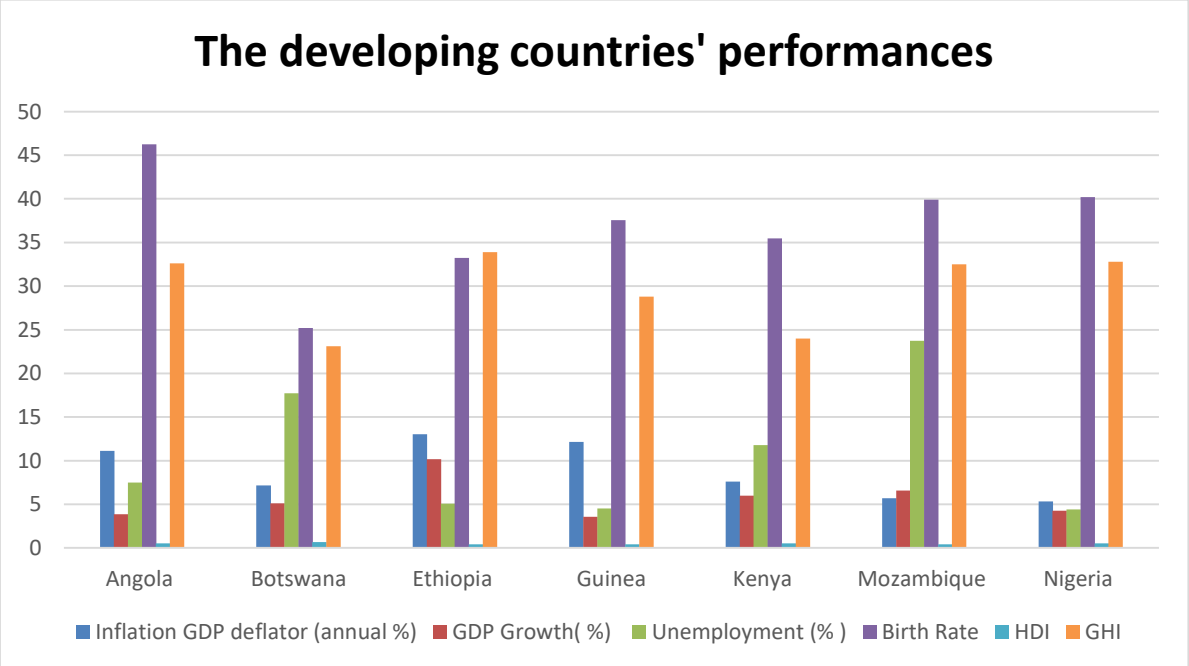
ii. **Food Aid** programs include criteria that focus on providing food assistance at different levels. The core issues emphasize social criteria, such as through emergency food transfers, food stamps, school meals, food for work projects, price subsidies for foods, and cash for food (S. Murphy & K. McAfee, 2005).

iii. The FAO's **Special Program for Food Security** (SPFS) is a package based on the following criteria: creating appropriate policies and regulations, providing training and improving farming technology and management practices, investing in roads and irrigation, raising farm incomes, creating more off-farm employment, fostering the conditions to increase food production, and increasing the production of staple food crops (E. E. Dooley, 2004).

4.2.2 The low use and high use of hunger criteria

Developing countries are shaped by many factors, but they share a common challenge in significantly reducing hunger levels. This is not an easy task, and it differs from country to country, because developing countries each have their own nature and character, as well as different key social, economic, and political indicators. These give a relatively detailed picture of the weaknesses in a country or region's performance. Developing countries typically show low performance in various economic and social indicators (see Figure 7), and these relate directly or indirectly to the different facets of the hunger problem. In addition, this low performance is reflected in the number of criteria applied by a country to deal with its hunger problem (as will be explained in Chapter 5). Figure 7 presents the performances of the different developing countries for selected social and economic indicators, namely inflation (GDP deflator, annual %), unemployment (%), the HDI (Human Development Index), GDP (Gross Domestic Product) growth (annual %), birth rate, and the GHI (Global Hunger Index).

Figure 7: The developing countries' performances on various selected economic and social indicators



Source: Own elaboration on data published by the World Bank, 2016

The GHI is the leading indication of the level of hunger in a developing country. In Figure 7, GHI values between 20.0 and 34.9 indicate a serious hunger problem, while the other indicators reflect different aspects of the hunger problem. Such indicators include inflation, GDP, and deflation; the birth rate; HIV/AIDS; HDI; political stability; and government effectiveness.

Some of these indicators play an important role in the empirical portion of this study, which is concerned with examining the **moderating effect** of different variables on the relationship between hunger-management models and GHI outcomes.[86] The potential moderators selected for this were the Human Development Index, Government Effectiveness, and Political Stability.

- The **inflation GDP deflator** (%)**:** This inevitably influences food prices, which can in turn lead to hunger. The affordability of food is essential, especially in developing countries where few people are immune to the effects of higher food prices (Schönfeldt et al., 2010).[87]
- **Birth rate** (per 1,000 persons): There is general agreement that lower birth rates contribute to economic development and help individuals and families to escape from poverty and hunger (Sinding, 2009).
- **HIV/AIDS:** This affects food insecurity in its own way. Households with a HIV-infected family member may have a reduced overall capacity to work due to the illness, which in turn reduces household income and depletes savings (Gillespie, 2006).
- **The HDI (Human Development Index):** There is a direct relationship between the HDI and hunger. Hunger interacts with human development on a basic level by threatening human life itself and blocking any opportunities to develop new capabilities, thus weakening physical and cognitive growth (HDI, 2012).

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[86] GHI outcomes- % of population that is undernourished; % children under five suffering from wasting; % of children under five suffering from stunting ; the mortality rate of children under the age of five.

[87] **The GDP deflator** is the overall inflation measure covering all price changes in the economy, not just at the consumer level.
The price deflator measures the magnitude of price increases and detects whether higher costs drive consumers away from a product.
https://dictionary.cambridge.org/dictionary/english/deflator

- **Political stability:** This reflects a stable political environment, which is a fundamental precondition for food security and development.
- **Government effectiveness:** This is important to reducing the hunger level, because it determines the efficacy of any policy or instrument the government employs to alleviate poverty and ensure food security (Birner, 2007; von Braun et al., 2009).

Country performances—as expressed by economic, social, and political indicators—have been found to motivate development and ensure food security. The social and economic contexts of a developing country's society is critically important, because these determine how much a country will succeed in addressing its hunger problem (Schwab, 2013). Developing a country's low economic, social, and political performances dictates the progress in reducing the hunger level over time.

Two factors affect the success of fighting hunger in developing countries, namely country performances and the number of criteria applied in fighting hunger.

Country performances: Government performance has long been recognized as determining the effectiveness and efficiency of the public sector. It is therefore a key element for public-sector reform (L. Ross, 2011). Other performances are also taken into account when considering a policy for addressing the poor economic growth in developing countries. These performances are usually expressed through different key indicators, whether they be economic, social, political, or other relevant indicators.

The **number of criteria applied in fighting hunger**: An important insight from Table 1 regards the behavior of developing countries when addressing their hunger problems. Different hunger programs, as presented by various organizations, offer a variety of criteria to combat the hunger problem in developing countries. Developing countries, even when they are located in the same region or using the same basic program (e.g., WFP food security) to fight their hunger problems, usually do not implement the original program in all its different criteria. In other words, most countries do not apply all seven of the criteria presented in Table 1 at once but rather focus on a subset of them. For example, Table 23 presents several countries that have applied fewer than the seven criteria to fight their hunger problems

Table 23: Number of criteria implemented by developing countries to fight against hunger

Country	Hunger program	Number of criteria implemented	GHI score 2016	Low/high use of hunger criteria
Angola	WFP Food Security	6	32.6	High
Bangladesh	Hunger Project	7	27.3	High
Bolivia	Zero Malnutrition	5	16.9	High
Cambodia	WFP Food Security	4	22.6	High
Cameroon	WFP Food Security	5	24.2	High
Ethiopia	WFP Food Security	5	33.9	High
Namibia	WFP Zero hunger	4	31.8	High
Nigeria	WFP Food Security	4	32.8	High
Suriname	Sustainable agriculture	1	10.4	Low
Yemen, Rep	WFP Food Security	1	34.2	Low
Bhutan	WFP	3	----	Low
Botswana	Food and Nutrition Security(FNS)	3	23.1	Low
Colombia	WFP Food Security	3	8.8	Low
Eritrea	Food insecurity	3	---	Low
Colombia	WFP Food Security	3	8.8	Low

Source: Own elaboration, based on Table 21

Following this insight, this study builds an original hunger-management model (i.e., a food scheme) that represents an effective combination of existing solutions for countries at different developmental levels. It provides a new way of thinking for the hunger problem, emphasizing that there is no need to develop new alternative programs with different criteria to address the hunger problem in developing countries, especially when it is clear how some programs include the same hunger criteria. Therefore, this hunger-management model highlights that it does not matter which solution to fight hunger is currently implemented in a certain country. Instead, what matters is the number of hunger criteria that are actually implemented in a country, those that play an initial roll in reducing hunger. Thus, the hunger-management model implemented in this study is a new tool, based on a new concept, to address the hunger problem more effectively. This new and unique approach has not previously been presented in the research literature.

In this study, the hunger-management model is based on two different hunger-fighting approaches: the low use of criteria and the high use of criteria in the hunger-fighting model. The study's sample comprised 131 developing countries, each of which apply some or all of the seven criteria. Countries that apply three or less criteria in their hunger-management models were classified into the "low use of criteria" group, which is sometimes referred to in this study as "the more problematic countries." Countries that apply four or more criteria in their hunger-management models, meanwhile, were classified into the "high use of criteria" group, which is sometimes referred to in this study as the "less problematic countries" (Table 22 ,More details about considerations for the division into two groups are presented in Chapter 5).

4.3 The importance of the hunger-management concept in addressing the level of hunger in developing countries

Addressing the hunger problem in developing countries is mainly reflected in a lower GHI score. Over the years, different organizations have made substantial efforts in promoting various hunger programs to achieve the first Millennium Development Goal (MDG1). Among its targets, it aims at "cutting by half the proportion of people who suffer from hunger by 2015." In reality, this target has not been met. Moreover, in 2015, member states of the United Nations committed to universal transformation, as presented in the 2030 Agenda, which commits to eliminating hunger by 2030. Although comprehensive efforts have been made to ensure the right to adequate food, empower females, and support family farming, as well as strengthen different capabilities within individuals and communities, hunger remains a significant problem in developing countries (UN, 2016).

Against this background, the new hunger-management concept presented in this study suggests a fresh insight to effectively reduce hunger problem in developing countries. This concept has several advantages over the other approaches introduced in the research literature, as listed below.

A direct relationship between the hunger level and the applied criteria in the hunger model

The common practice for tracking progress in the hunger level is to follow the GHI score and its four component indicators over a certain period.[88] Researchers, as well as policy makers, link the hunger level with different economic, social, and political indicators, which can be simple[89] or complex[90] indicators. In general, researchers point out the strong relationship between the value of an indicator and the hunger level of a country, regardless of whether it is a complex or single indicator. Complex indicators provide a cross-sectional overview of a country's various issues, especially in the case of developing countries. These indicators help to indirectly study the various factors that influence the level of hunger in a country. Single indicators, meanwhile, highlight particular issues from which one can draw inferences about the hunger level in a specific country. Indicators can therefore indicate problems that contribute to the hunger issue. Such follow-up and interpretation about the hunger level can sometimes be misleading, however, because it does not directly indicate the relationship between a specific hunger program model and the criteria implemented and the GHI score of the particular country. Simple or complex indicators are therefore indirectly reflected in the hunger level.[91]

In contrast, the new hunger-management model shows a direct relationship between the hunger level and the hunger criteria applied in the model. Furthermore, this could also highlight differences in the low use of hunger criteria and the high use of hunger criteria. Therefore, how do these uses of criteria directly reflect on the hunger level (GHI score)? This will be shown in the data analysis in Chapter 5.

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[88] undernourished (%), wasting in children under five (%), stunting children in under five (%), mortality rate for children under five (%)

[89] ***Simple indicators*** are expressed in units. For example, the **birth rate** is the average annual number of births during a year for every 1,000 people in the population (NationMaster, 2013), while the **unemployment rate** is the percentage of unemployed workers in the total labor force (OECD, 2017).

[90] ***Complex indicators*** combine multiple single indicators into an index that is then expressed as a dimensionless number. For example, the **HDI** is a summarized measure for the average achievement in various key dimensions of human development, such as health, education, and standard of living. Ranging from 0 to 1, a low human development is anything below 0.550 (UNDP, 2016). **Government Effectiveness** measures the quality of public services, the quality of the civil service, and its independence from political pressure. This indicator is based on up to 15 different assessments and surveys (World Bank, 2016). The score ranges from -2.5 (weak) to 2.5 (strong) (Global Economy, 2016).

[91] Compare it to a person who wants to check whether he or she lost weight: The **direct way** is to use weighing scale, while an **indirect way** would be to take blood test and see if it shows improvements in various marker that indirectly indicate weight loss.

A tracking and analyzing tool: The hunger-management model with the new concept of low and high use of criteria represents an effective tool for tracking and analyzing the progress of different countries over time under different policies, each with various criteria. On a practical level, it indicates criteria that lead to better progress in the war against hunger, which could be on a national or regional level.

Tailored hunger solutions: The hunger-management model presented in this study provides a unique tool for tailoring a hunger program to fit the particular development level of a developing country, thus leading to hunger solutions that are more effective.

New insights: The concept of the hunger-management model helps to gain new insights that may support future decision-making in the fight against hunger in developing countries.

Conclusions

Various efforts are made to fight hunger in its various facets through different types of hunger programs in developing countries. Four leading organizations have implemented four basic policies, each comprising various criteria to fight hunger, although some policies promote similar criteria. By the word "criteria," this study refers to the means used to address the hunger issue, and this could include encouraging farming, providing school meals, implementing food waste programs, supplying food aid, and so on. The policies introduced in this chapter includes the EU's (European Union) leading food security policy, the FAO's (Food and Agriculture Organization) leading rural development policy integrating agricultural and non-agricultural aspects of rural life; the HP's (Hunger Project) leading policy of an innovative holistic approach that empowers women and men living in rural villages; and the WFP's (World Food Program) leading policy that focuses on strengthening individual and government capacities in different fields.

The concept of the hunger-management model introduced in this study represents a new tool for addressing the hunger problem in developing countries in a more effective way. In fact, this study builds an original hunger-management model (i.e., food scheme) based on effective combinations of existing solutions for countries at different levels of development. This hunger-management model is based on two different hunger-fighting approaches, namely the low use of criteria and the high use of criteria in the hunger-management model. There are two points of interest when fighting hunger in developing countries. Developing countries may show low

performances in different social, economic, and political indicators, and this could influence the number of criteria a country should implement to make progress on its hunger level over time. In turn, the number of applied criteria in the hunger model has a substantial effect on reducing the hunger level over time.

The hunger-management concept presented in this study suggests a new way to effectively address the hunger problem in developing countries. This has several advantages over the existing approaches introduced in the research literature, including a direct relationship between the hunger level and the criteria applied in the hunger model. Other indicators, whether simple or complex, are indirectly reflected in the hunger level. In addition, it provides a tool for tracking and analyzing progress under different hunger model criteria and allows the tailoring of hunger solutions based on effective combinations of existing solutions for countries at different levels of development. Finally, it helps gain new insights that may support future decision-making in the fight against hunger in developing countries.

Chapter 5: Interdependencies of country's hunger-management model and Global Hunger Index progress

5.1 Research methodology and research assumptions

Sample description

To examine the association between the model for addressing hunger (i.e., the hunger-management model) used by countries and the level of hunger over time, data for 131 countries were gathered. This study's data analysis draws on relevant data for the *Global Hunger Index (GHI)*. In addition, data was sourced for four examined moderators: *Corruption Index, Human Development Index, Government Effectiveness and Political Stability.*

Global Hunger Index (GHI): The International Food Policy Research Institute (IFPRI) calculates GHI scores every year, which rank countries on a 100-point scale that reflects five levels of hunger. A score less than 10.0 indicates low hunger, a value between 10.0 and 19.9 reflects moderate hunger, values from 20.0 to 34.9 indicate serious hunger, values from 35.0 to 49.9 reflect alarming levels of hunger, and values in excess of 50.0 reflect extremely alarming hunger. The GHI comprises four component indicators. (1) The percentage of the population that is undernourished (PUN) measures inadequate food supply, an important indicator of hunger that refers to the entire population. This index is used as a leading indicator for international hunger targets, including the SDGs (Sustainable Development Goals). There is also (2) the percentage of children under the age of five suffering from wasting (CWA) and (3) the percentage of children under the age of five suffering from stunting (CST). These two indicators go beyond calorific availability and consider aspects of diet quality and utilization. Children are particularly vulnerable to nutritional deficiency, and stunting and wasting are nutritional indicators for the SDGs. Finally, there is (4) the mortality rate of children under the age of five (CM). Death is the most serious consequence of hunger, and children are the most vulnerable to it. Each of the four component indicators is given a standardized score, which are then aggregated to calculate the GHI score for each country.

The GHI score for a country is given by:

(1/3 × Standardized PUN) + (1/6 × Standardized CWA) + (1/6 × Standardized CST) + (1/3 × Standardized CM), (GHI data source: Global Hunger index sites)

Human Development index (HDI): The HDI is a summary measure of average achievement in key dimensions of human development. It combines three dimensions: the health dimension, as assessed by life expectancy at birth; the education dimension, as measured by mean years of schooling for adults aged 25 years or older and the expected years of schooling for children of school-entering age; and the standard of living dimension, as measured by gross national income (GNI) per capita in PPP US$. The scores for these three HDI dimensions indices are then aggregated into a composite index using the geometric mean:

$$HDI = (I_{Health} * I_{Education} * I_{Income})^{1/3}$$

The HDI scores are grouped into four levels: very high human development (0.800 or higher), high human development (0.700–0.799), medium human development (0.550–0.699), and low human development (under 0.550). (HDI data source: United Nation Development Program, Human Development Reports)

Political Stability Index: The Political Stability Index is a proprietary index measuring a country's level of stability, standard of good governance, record of constitutional order, respect for human rights, and overall strength of democracy. The Political Stability Index is calculated using a methodology established by Country Watch's editor-in-chief. It is a composite measure, because it is based on several other indexes from multiple sources. It measures the dynamic between the quality of a country's governance and the threats that could compromise and undermine stability, such as armed conflict, violent demonstrations, social unrest, international tensions, and terrorism, as well as ethnic, religious, or regional conflicts. Scores are assigned from 0 to10, with a score of 0 representing the lowest level of political stability and a score of 10 signifying the highest possible level of political stability. The scale spectrum ranges between -2.5 (weak political stability) and 2.5 (strong political stability). (Political Stability Index data source: The World Bank)

Government Effectiveness: This indicator measures the quality of public services, the quality of the civil service (and its independence from political pressure), the quality of policy formulation and implementation, and the credibility of a government's commitment to its stated policies. The indicator is an index that combines up to 15 different assessments and surveys, depending on availability. Each of these receives a different weight depending on its estimated precision and country coverage. (Government Effectiveness data source: Worldwide Governance Indicators (WGI) and the World Bank)

Corruption Perception Index (CPI): The Corruption Perception Index measures countries based on their perceived level of corruption. It ranges from 0 (highly corrupt) to 10 (clean). The CPI was created by, and is used by, Transparency International, an international nongovernmental organization. The CPI is based on surveys of domestic and international business executives, financial journalists, and risk analysts. It therefore reflects the perceptions of experts and business elites rather than that of the general public. It averages scores from several polls and surveys for each respective country for the two years prior to its release. The minimum number of surveys for each country is three, although some countries are evaluated using as many as 14 or 15 surveys. The CPI focuses on the public sector and evaluates the degree of corruption among public officials and politicians. A country's rank indicates its position relative to the other countries included in the index. (Data source for CPI: Transparency International.)

Measures

The measures presented below were gathered for each country.

Type of hunger policy: Various types of programs are used to cope with the hunger issue in different countries. Some 71.8% of countries in this study's sample use the WFP model, while 28.2% use other models, such as the "Hunger and Poverty program" or the "Rural development program."

Applied criteria for hunger model: Several criteria can be applied to cope with hunger in a particular country, such as encouragement of farming, provision of school meals, food waste programs, food aid, knowledge provision, agriculture development programs, and food banks. For each criterion, a score of 1 was given where a particular country uses it and 0 otherwise. The number of criteria that each country uses ranged between 0 and 6, with a median of 3 criteria, so 50% of the countries in the sample used 3 criteria or less, while 50% of countries used 4 criteria or more. Based on this, countries were divided into the "low use of hunger criteria" and the "high use of hunger criteria." This measure served as the independent variable (a categorical *predictor*) in this research.

Global Hunger Index. To assess the effects of using various hunger model criteria, the *Global Hunger Index* was used. This index comprises several outcomes:

- The proportion of undernourished people in the population (%)
- The prevalence of wasting in children under five years old (%)

- The prevalence of stunting in children under five years old (%)
- The under-five mortality rate (%)
- The general score

Data for these outcomes were gathered for several representative years[92] (1992, 2000, 2008, and 2016), so trends over time could be assessed.

Data analysis

Main goal of current study is to evaluate the effect of implementing hunger coping strategies, on hunger outcomes in the national level, using longitudinal design. To do so, first, I allocated each country into low implementation of hunger coping strategies, versus high implementing of hunger coping strategies. This allocation was conducted using number of applied criteria for hunger model. Second, I calculated hunger outcomes for each country over time (specifically in the following years 1992, 2000, 2008 and 2016 in order to show continuous trend of the effect of using efficacious hunger model.

Main statistical model that used to test main research question is Repeated Measures Analysis of Variance, because this procedure enables to calculate significant change over time according to group attribution (low vs. high hunger model).

Repeated measures ANOVA is the equivalent of the one-way ANOVA, but for related, not independent groups, and is the extension of the dependent t-test. A repeated measures ANOVA is also referred to as a within-subjects ANOVA or ANOVA for correlated samples. This test has three effects:

- Main effect of time (within subject effect) - a significant change over time in a respective hunger outcome in total.
- Main effect of group (between subject effect) - a general significant difference between two groups: countries that use low level of hunger model implementation vs. countries that use high level of hunger model implementation.

[92] **Representative years**: The chosen representative years was constrained by data availability. Dealing with developing countries is dependent on data availability, and some countries do not regularly report data due to conflict, lack of statistical capacity, and other reasons.

- Interaction effect – whether change over time *depends* on the hunger management model, meaning, is there a trend of change over time that differs between two types of countries. Having interaction effect emphasize the difference in hunger indices over time.

To probe differences between years, post hoc analysis was conducted using Bonferroni correction.

Repeated measures ANOVA relies on several assumptions that were tested and confirmed in the data set:

Assumption #1: Dependent variable should be measured at the continuous level (i.e., they are interval or ratio variables). All dependent variables that were used in the current study were indeed at the continuous level since they were measured by percentages (Undernourished Population (%), Wasting children under five (%), Stunting children under five (%) and Under five mortality rate (%). Final outcome which was also measured at the continuous level was general hunger score. Hence, this assumption is confirmed in my dataset.

Assumption #2: Independent variables (type of country and measurement points) should each consist of two or more categorical groups. Between-subject variable should include two or more separate categorical groups (that is each country should be included in a single group only). Within-subject variable should include two or more related groups. Hence, this assumption is confirmed in my dataset

Assumption #3: Independence of observations, which means that there is no relationship between the observations between the groups themselves. This assumption is confirmed in my dataset since each observation is independent and not related between groups.

Assumption #4: There should be no significant outliers. Outliers are data points within data that do not follow the usual pattern. The problem with outliers is that they can have a negative effect on the two-way ANOVA, reducing the accuracy of results. I have tested all outcomes in dataset for outliers using box plots and found no extreme outliers that could bias results.

Assumption #5: There needs to be homogeneity of variances for each combination of the groups of the two independent variables. I used Levene's test for homogeneity of variances which also confirmed in my data analyses.

Finally, moderation effects of additional variables were examined using repeated measures ANOVAs with covariance. These analyses used to detect other variables which

influence time trend for hunger indices between countries. The following moderators were examined: Corruption Index, Human Development Index, Government Effectiveness, and Political Stability.

Research assumptions

This study is based on three premises that are relevant to developing countries' progress in reducing the hunger level over time:

(i) **The effectiveness of different solutions**: Tracking the Global Hunger Index scores of developing countries over time does show positive progress. This study interprets this positive outcome as the effectiveness of different implemented hunger solutions in each developing country in coping with its hunger problem**.**

(ii) **Any action delivers positive results**: GHI scores and other indicators show definitive improvements across all four parameters, namely the proportion of undernourished people in the population (%), the prevalence of wasting in children under five (%), the prevalence of stunting in children under five (%), and the under-five mortality rate (%). This study interprets this positive trend as indicating that any action to address the hunger problem in developing countries inevitably delivers positive results at some level, as expressed by the improved GHI scores over time.

(iii) **Countries' socioeconomic profiles reflect on GHI progress**: Countries with differing development levels differ in their socioeconomic profiles. This is expressed by different socioeconomic performances, so each developing country reacts differently to a particular hunger-management program. This accounts for the differing levels of progress that are achieved in GHI scores over time with a particular hunger solution.

These three assumptions emphasize the need to build hunger solutions to fit countries at different levels of development.

5.2 Research limitations

This study has two major limitations regarding:

(i) Hunger-management criteria

(ii) Regions' applied criteria

(i) Hunger-management criteria: The hunger-management model incorporates the low or high use of hunger model criteria. The difference between these two approaches is the number of criteria employed to cope with a hunger problem. The number of criteria applied by a country is an important factor reflecting directly on a country's progress in reducing its level of hunger, as has already been presented in the data analysis and conclusion sections.

In our case, the hunger model to fight hunger is based on seven criteria that are key to fighting hunger. Each criterion also has other sub-criteria. For example, a food aid program has three sub-criteria: donor countries directly transferring food aid, donor countries providing cash for food, and government direct and indirect food support. Another example is how supporting small farms can comprise several sub-programs, such as providing farmers' families with financial assistance, supplying seed and fertilizer subsidies, and supporting the development of infrastructure and irrigation systems. Thus, implementing such a program does not imply that all of its sub-programs will be implemented by a government. This could ultimately reflect on a country's progress in reducing its hunger score over time. Therefore, this study recommends also including the sub-criteria with the hunger model criteria. This could bring better insights into the relationship between a hunger-management model and the level of hunger.

(ii) Regions' applied criteria: This study focused on developing countries in different regions, such as Africa, South America, and Asia. These countries have differing points of interest when addressing their hunger problems, such as agricultural and/or social issues. Those issues could be reflected in the chosen criteria applied by a country in its hunger-management model, ultimately reflecting on the outcome.

5.3 Relationship between various hunger outcomes and hunger-management models

This subsection examines whether countries that apply high hunger management enjoy from better hunger outcomes in comparison with countries that apply low hunger management. Current study examined the following hunger outcomes: undernourished in population (%); wasting in children under five years (%); stunting in children under five years (%); Under five mortality rate (%); and hunger score. These outcomes were chosen for two main reasons. First, these are acceptable and common indices for measuring hunger in the national level. Second, these indices have been measured for several periods by international institutes in a way that enable valid and reliable evaluation of main research question. Hunger-management models are based on two basic concepts: the *high use of criteria* and the *low use of criteria*. These two hunger-management models indirectly indicate countries with different levels of development.

Table 24 shows the frequencies of using each criterion in a hunger model. As seen in this table, almost all countries implement an agricultural development program, and most countries encourage farming (79.4%) and provide food aid (65.6%). In addition, half of the countries (52.7%) provide school meals. However, only 42.7% of countries in this sample use the knowledge component, and even fewer implement food bank (10.4%) and food waste programs (7.6%).

Table 24: Frequency of use for various criteria in hunger-management models

	Criterion for Hunger Model	**% of use of total sample**
1	**Encouraging farming**	79.4
2	**School meals**	52.7
3	**Food waste program**	7.6
4	**Food aid**	65.6
5	**Knowledge**	42.7
6	**Agricultural-development program**	98.1
7	**Food banks**	10.4

Source: Own elaboration based on sample countries' data

***Country Proportion of undernourished in population* (%)**

Table 25: Means and Standard Deviations for Low and High Countries of Using Hunger Model in Proportion of Undernourished in Population

		M	SD	N	Post hoc differences between countries
1992	High use in hunger criteria	28.19	16.827	21	<.001
	Low use in hunger criteria	34.07	14.927	44	
	Total	32.17	15.680	65	
2000	High use in hunger criteria	24.57	12.351	21	<.001
	Low use in hunger criteria	31.41	12.528	44	
	Total	29.20	12.787	65	
2008	High use in hunger criteria	20.14	10.066	21	.056
	Low use in hunger criteria	24.68	11.127	44	
	Total	23.22	10.928	65	
2016	High use in hunger criteria	17.00	8.637	21	.670
	Low use in hunger criteria	20.61	12.244	44	
	Total	19.45	11.267	65	

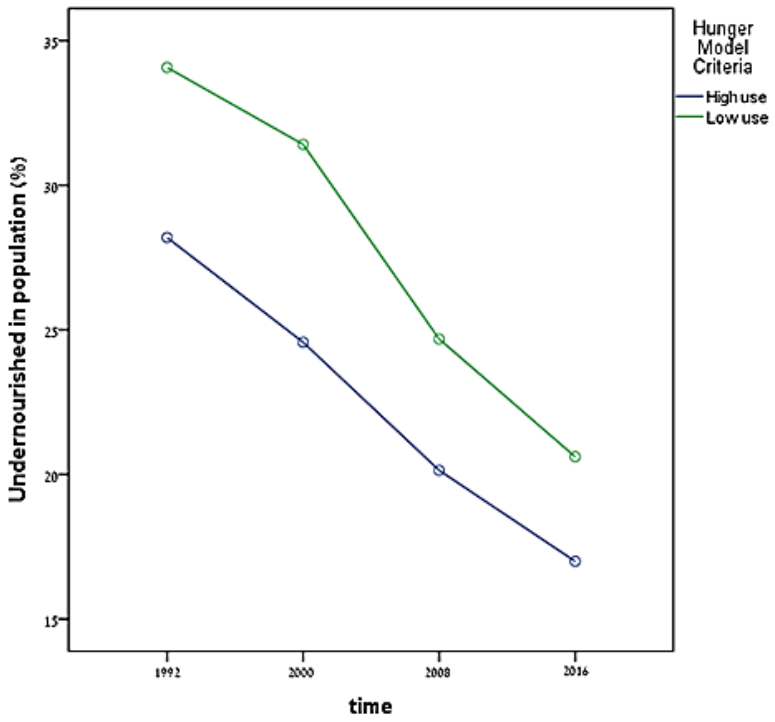
For total countries in the sample, a main effect of time was found, $F(3,189)=32.88$, $p<.001$, $\eta^2=.343$. More specifically, a significant decrease was found in proportion of undernourished in population between 1992 (32.17%) to 2000 (29.20%) ($p<.05$), from 2000 to 2008 (23.22%) ($p<.01$), and from 2008 to 2016 (19.45%) ($p<.01$). (See Figure 8).

In addition, a significant difference was found across all years between countries, while countries that used 4 criteria or more from hunger model had lower proportion of undernourished in population at all examined years, $F(1,63)=3.21$, $p<.05$, $\eta^2=.049$.

No significant interaction was found between usage in criteria for hunger model and time for proportion of undernourished in population, $F(3,189)=0.547$, $p=.651$, $\eta^2=.009$. In other words, change of proportion of undernourished in population over time did not differ between the two groups of countries according to level of use in hunger model criteria. It is important to note that significant differences were found between two types of countries at 1992 ($p<.001$) and 2000

($p<.001$) using post hoc analyses. That is, in these years countries which highly implemented hunger model had less proportion of undernourished in population in comparison with countries which had low implementation hunger model. These differences weaken (and hence were not significant) at 2008 and 2016.

Figure 8: Proportion of Undernourished in Population in different Hunger Management Models



Examining moderation effect of Corruption index on the relationship between hunger management model and hunger outcome (undernourished in population), did not yield a significant interaction, $F(3,165)=1.483$, $p=.221$, $\eta^2=.026$. In other words, implemented hunger management model significantly differentiates the undernourished proportion whereas the latter is not significantly interacted by level of Corruption index.

Examining moderation effect of Human Development Index on the relationship between hunger model and outcome, also did not yield a significant interaction, $F(3,165)=1.354$, $p=.258$, $\eta^2=.022$. That is, countries that implement different levels of hunger model do not differ by level of Human Development index.

Yet again, examining moderation effect of Government Effectiveness on the relationship between hunger model and outcome, did not yield a significant interaction, $F(3,174)=1.104$, $p=.349$, $\eta^2=.019$.

Examining moderation effect of Political Stability on the relationship between hunger model and outcome, also did not yield a significant interaction, $F(3,171)=0.420$, $p=.739$, $\eta^2=.007$.

Prevalence of wasting in children under five years (%)

Table 26: Means and Standard Deviations for Low and High Countries of Using Hunger Model in Prevalence of Wasting in Children Under Five Years (%)

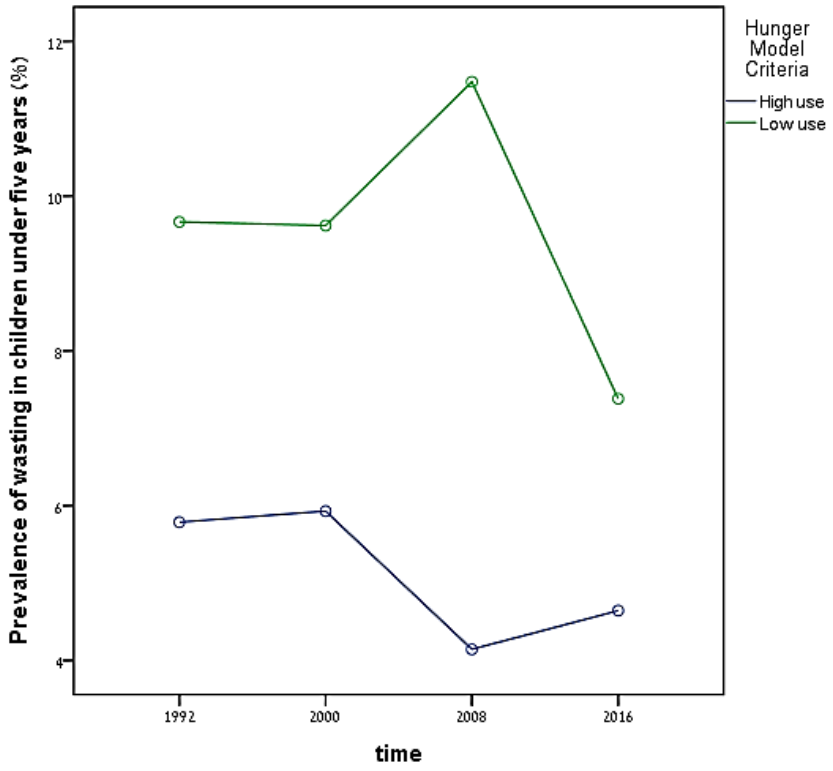
		M	SD	N	Post hoc differences between countries
1992	High use in hunger criteria	5.79	5.323	14	.026
	Low use in hunger criteria	9.67	6.003	21	
	Total	8.11	5.979	35	
2000	High use in hunger criteria	5.93	5.313	14	.004
	Low use in hunger criteria	9.62	4.904	21	
	Total	8.14	5.320	35	
2008	High use in hunger criteria	4.14	3.592	14	.002
	Low use in hunger criteria	11.48	14.989	21	
	Total	8.54	12.263	35	
2016	High use in hunger criteria	4.64	3.973	14	.023
	Low use in hunger criteria	7.38	5.500	21	
	Total	6.29	5.068	35	

For total countries in the sample, no main effect of time was found: $F(3,99)=0.710$, $p=.548$, $\eta^2=.021$. This means that, no change over time has occurred for all countries in the sample in prevalence of wasting in children under five years (See Figure 9).

However, a significant difference was found across all years between countries while countries that used 4 criteria or more from hunger model, had lower proportion of wasting in children under five years at all years examined: $F(1,33)=5.704$, $p<.05$, $\eta^2=.147$.

No significant interaction was found between usage of different hunger models and time: $F(3,99)=0.928$, $p=.430$, $\eta^2=.027$. In other words, change of prevalence of wasting in children under five years over time did not differ between two groups of countries according to the level of use in hunger model criteria. It is important to note that significant differences were found between two types of countries at 1992 ($p<.05$), 2000 ($p<.05$), 2008 ($p<.05$) and 2016 ($p<.05$) using post hoc analyses. That is, in all years tested, countries which highly implemented hunger model had less prevalence of wasting in children under five years.

Figure 9: Prevalence of Wasting in Children Under Five Years Depends on Intense of Use in Hunger Model Criteria



Examining moderation effect of Corruption index on the relationship between hunger model and outcome, did not yield a significant interaction, $F(3,87)=1.380$, $p=.254$, $\eta^2=.045$.

Examining moderation effect of Human Development Index on the relationship between hunger model and outcome, did not yield a significant interaction, $F(3,90)=0.527$, $p=.665$, $\eta^2=.017$.

Examining moderation effect of Government effectiveness on the relationship between hunger model and outcome again, did not yield a significant interaction, $F(3,87)=1.683$, $p=.177$, $\eta^2=.055$.

Examining moderation effect of Political Stability on relationship between hunger model and outcome also, did not yield a significant interaction, $F(3,84)=0.547$, $p=.651$, $\eta^2=.019$.

Hence, Corruption index, Human Development Index, Government effectiveness and Political Stability do not affect change in prevalence of wasting in children under five years over time between countries.

Prevalence of stunting in children under five years (%)

Table 27: Means and Standard Deviations for Low and High Countries of Using Hunger Model in Prevalence of Stunting in Children Under Five Years (%)

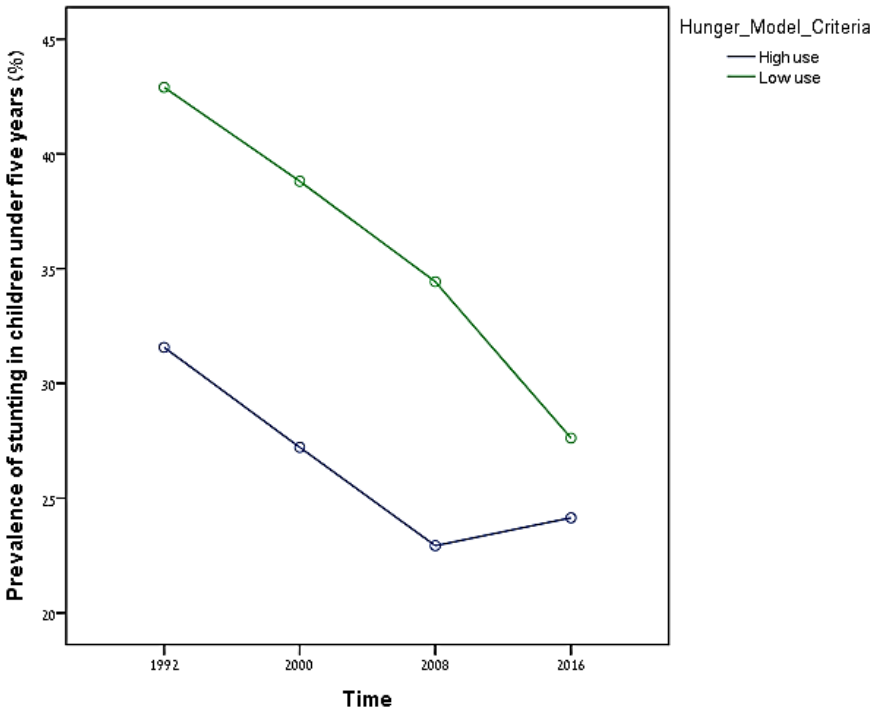
		M	SD	N	Post hoc differences between countries
1992	High use in hunger criteria	31.57	14.75	14	.002
	Low use in hunger criteria	42.90	11.66	21	
	Total	38.37	13.96	35	
2000	High use in hunger criteria	27.21	16.01	14	<.001
	Low use in hunger criteria	38.81	12.01	21	
	Total	34.17	14.70	35	
2008	High use in hunger criteria	22.93	14.12	14	<.001
	Low use in hunger criteria	34.43	10.50	21	
	Total	29.83	13.18	35	
2016	High use in hunger criteria	24.14	17.91	14	.030
	Low use in hunger criteria	27.62	10.19	21	
	Total	26.23	13.66	35	

For total countries in the sample, a main effect of time was found, $F(3,99)=14.64$, $p<.001$, $\eta^2=.307$. More specifically, a significant decrease was found in prevalence of stunting in children under five years between 1992 (38.37%) to 2000 (34.17%) ($p<.05$), from 2000 to 2008 (29.83%) ($p<.01$), and from 2008 to 2016 (26.23%) ($p<.01$). (See Figure 10).

In addition, a significant difference was found across all years between countries while countries that used 4 criteria or more from hunger model had lower prevalence at all years examined: $F(1,33)=5.79$, $p<.05$, $\eta^2=.149$.

However, no significant interaction was found between usage in criteria for hunger model and time: $F(3,99)=2.363$, $p=.076$, $\eta^2=.067$. That is, the change of prevalence of stunting in children under five years over time did not differ between the two groups of countries according to level of use in hunger model criteria. It is important to note that significant differences were found between two types of countries at 1992 ($p<.05$), 2000 ($p<.01$), 2008 ($p<.01$) and 2016 ($p<.05$) using post hoc analyses. That is, in all years tested, countries which highly implemented hunger model had less prevalence of stunting in children under five years.

Figure 10: Prevalence of Stunting in Children Under Five Years Depends on Intense of Use in Hunger Model Criteria



Examining moderation effect of Corruption index on relationship between hunger model and outcome, did not yield a significant interaction, $F(3,87)=0.185$, $p=.907$, $\eta^2=.006$.

Examining moderation effect of Human Development Index on relationship between hunger model and outcome, did not yield a significant interaction, F(3,90)=1.057, p=.372, η^2=.034.

Examining moderation effect of Government effectiveness on relationship between hunger model and outcome, did not yield a significant interaction, F(3,87)=0.449, p=.718, η^2=.015.

Examining moderation effect of Political Stability on relationship between hunger model and outcome, did not yield a significant interaction, F(3,84)=0.113, p=.952, η^2=.004.

Hence, Corruption index, Human Development Index, Government effectiveness and Political Stability do not affect change in prevalence of stunting in children under five years over time between countries.

Under five mortality rate (%)

Table 28: Means and Standard Deviations for Low and High Countries of Using Hunger Model in Under five mortality rate (%)

		M	SD	N	Post hoc differences between countries
1992	High use in hunger criteria	6.23	5.71	61	<.001
	Low use in hunger criteria	12.05	6.84	61	
	Total	9.14	6.92	122	
2000	High use in hunger criteria	5.21	5.30	61	<.001
	Low use in hunger criteria	10.05	5.84	61	
	Total	7.63	6.06	122	
2008	High use in hunger criteria	3.93	4.07	61	<.001
	Low use in hunger criteria	7.25	4.39	61	
	Total	5.59	4.53	122	
2016	High use in hunger criteria	2.87	2.99	61	<.001
	Low use in hunger criteria	5.36	3.56	61	
	Total	4.11	3.50	122	

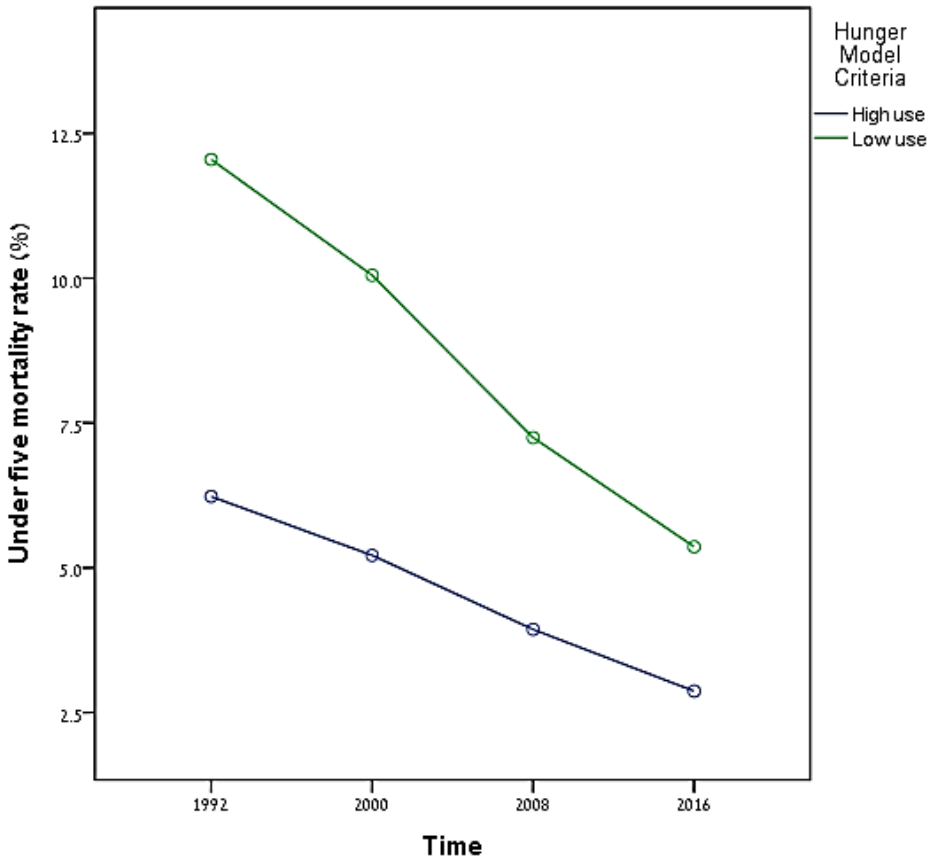
For total countries in the sample, a main effect of time was found, F(3,360)=161.421, p<.001, η^2=.574. More specifically, a significant decrease was found in prevalence of children

mortality between 1992 (9.14%) to 2000 (7.63%) ($p<.05$), from 2000 to 2008 (5.59%) ($p<.01$), and from 2008 to 2016 (4.11%) ($p<.01$). (See Figure 11).

In addition, a significant difference was found across all years between countries while countries that used 4 criteria or more from hunger model had lower mortality rates at all years examined, $F(1,120)=23.35$, $p<.01$, $\eta^2=.163$.

A significant interaction was found between usage in criteria for hunger model and time, $F(3,360)=18.40$, $p<.001$, $\eta^2=.133$. Specifically, in 1992 and 2000, countries with high use in hunger model criteria showed significant lower rates of children mortality in compare with countries with low use in 1992 ($p<.001$), 2000 ($p<.001$), 2008 ($p<.001$) and 2016 ($p<.001$). However, differences in 2008 and 2016 were smaller in comparison with differences in 1996 and 2000.

Figure 11: Under Five Mortality Rate Depends on Intense of Use in Hunger Model Criteria



Examining moderation effect of Corruption index on the relationship between hunger model and outcome, did not yield a significant interaction, $F(3,333)=1.034$, $p=.512$, $\eta^2=.021$.

Examining moderation effect of Human Development Index on relationship between hunger model and outcome, did not yield a significant interaction, $F(3,348)=0.236$, $p=.871$, $\eta^2=.002$.

Examining moderation effect of Government effectiveness on relationship between hunger model and outcome did not yield a significant interaction, $F(3,339)=0.956$, $p=.414$, $\eta^2=.008$.

Examining moderation effect of Political Stability on relationship between hunger model and outcome, did not yield a significant interaction, $F(3,339)=0.875$, $p=.454$, $\eta^2=.008$

Hence, Corruption index, Human Development Index, Government effectiveness and Political Stability do not affect change in prevalence of under-five mortality rate over time between countries.

General hunger score

Table 29: Means and Standard Deviations for Low and High Countries of Using Hunger Model in General Hunger Score

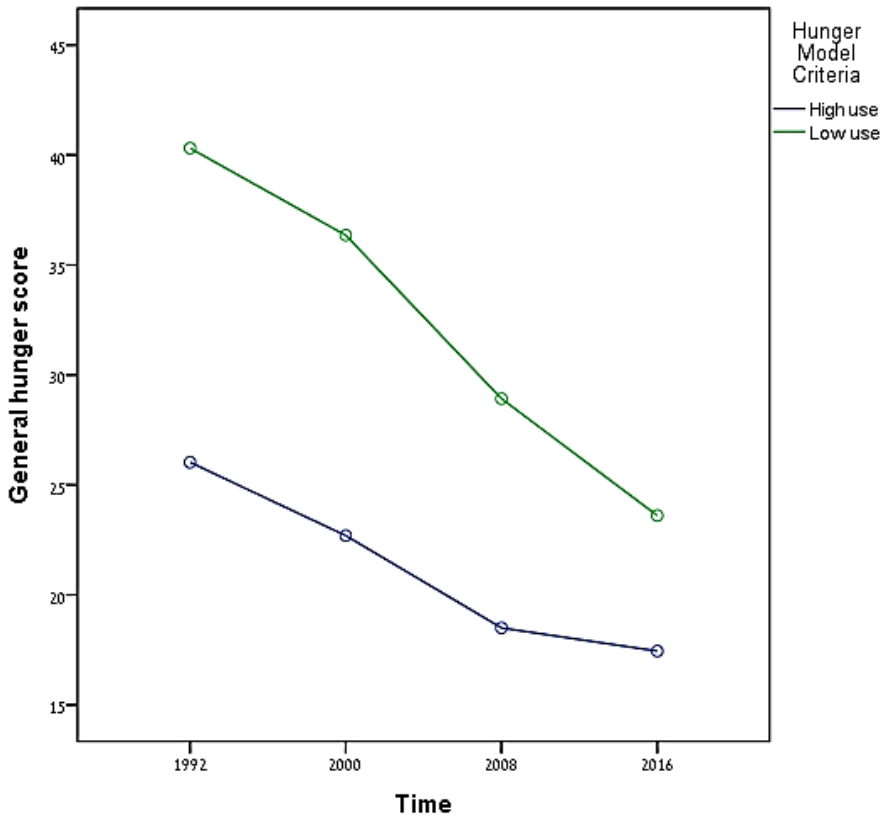
		M	SD	N	Post hoc differences between countries
1992	High use in hunger criteria	26.03	15.32	36	<.001
	Low use in hunger criteria	40.31	13.72	51	
	Total	34.40	15.97	87	
2000	High use in hunger criteria	22.69	14.07	36	<.001
	Low use in hunger criteria	36.35	12.22	51	
	Total	30.70	14.60	87	
2008	High use in hunger criteria	18.50	12.20	36	<.001
	Low use in hunger criteria	28.92	9.39	51	
	Total	24.61	11.77	87	
2016	High use in hunger criteria	17.44	14.08	36	<.001
	Low use in hunger criteria	23.61	8.94	51	
	Total	21.06	11.68	87	

For total countries in the sample, a main effect of time was found, $F(3,255)=84.92$, $p<.001$, $\eta^2=.500$. More specifically, a significant decrease was found in hunger score between 1992 (34.40%) to 2000 (30.70%) ($p<.05$), from 2000 to 2008 (24.61%) ($p<.01$), and from 2008 to 2016 (21.06%) ($p<.01$). (See Figure 12).

In addition, a significant difference was found across all years between countries while countries that used 4 criteria or more from hunger model had lower hunger score at all years examined, $F(1,85)=20.03$, $p<.01$, $\eta^2=.121$.

A significant interaction was found between usage in criteria for hunger model and time, $F(3,255)=9.09$, $p<.001$, $\eta^2=.097$. That is, in 1992 and 2000, countries with high use in hunger model criteria showed significant lower rates of hunger general score in compare with countries with low use ($p<.001$). These difference were also significant at 2008 ($p<.001$) and 2016 ($p<.001$) but to less extent.

Figure 12: Hunger Score Depends on Intense of Use in Hunger Model Criteria



Examining moderation effect of Corruption index on relationship between hunger model and outcome, did not yield a significant interaction, $F(3,231)=0.296$, $p=.828$, $\eta^2=.004$.

Examining moderation effect of Human Development Index on relationship between hunger model and outcome again, did not yield a significant interaction, $F(3,249)=0.462$, $p=.709$, $\eta^2=.006$.

Examining moderation effect of Government effectiveness on relationship between hunger model and outcome, once again did not yield a significant interaction, $F(3,236)=0.592$, $p=.621$, $\eta^2=.007$.

Examining moderation effect of Political Stability on relationship between hunger model and outcome, also did not yield a significant interaction, $F(3,234)=0.424$, $p=.736$, $\eta^2=.005$.

Hence, Corruption index, Human Development Index, Government effectiveness and Political Stability do not affect change in prevalence of general hunger score over time between countries.

The main results

The change over time for each outcome depends upon the number of criteria (low or high) used in the hunger-management model.

1. **Positive effect over time:** All countries in the sample, both with high and low use of hunger model criteria, experienced improvements over time. Significant decreases were found for the following outcomes: the proportion of undernourished in the population, the prevalence of stunting in children under five years old, the child mortality rate, and the general hunger score.

2. **Two different behaviors to fight hunger were also evident**: Significant differences were observed across all years between the two country groups, with countries using four or more criteria in their hunger-management models (high use) having lower scores for all hunger outcomes, including the proportion of undernourished in population, the prevalence of wasting in children under five years old, the prevalence of stunting in under-fives, the under-five mortality rate, and the general hunger score.

3. **Moderation effects:** Examining the moderating effect of potential moderators[93] on the relationship between hunger management models and outcomes did not reveal any significant

[93] **Four moderators**: Corruption Index, Human Development Index, Government Effectiveness, and Political Stability

interactions. In short, countries that implement different levels of criteria in their hunger models (i.e., low and high use of criteria) do not differ in their levels for any of the examined moderators.

Hence, main conclusion is that overall, countries which highly implemented hunger criteria model, succeeded to achieve favorable hunger outcomes. This effect was stable overtime which emphasize the importance of implementing such interventions to create long-term beneficial effects that could reduce hunger negative outcomes.

5.4 Suggestions for further research

(i) Region-based hunger criteria: Developing countries in a particular region may share similar issues, such as agricultural and/or social problems, so they may also share similar points of interest when addressing their hunger problems. This could be further reflected in the hunger criteria they apply in their hunger-management models. This indicates a need to base a hunger-management model on the specific nature or characteristics of a region. In other words, hunger-management models developed for regions with unique natures could help to gain a better understanding of the link between a hunger-management model and the level of hunger, as well as improve those countries' progress in reducing their level of hunger. Such analysis could also support the results already obtained in this study.

(ii) Extend the research to other regions and countries: Expanding the scope of this study is an important next step in establishing this unique new hunger solution concept for countries at different development levels. Such an extended study could reinforce the results already found in this research, and it could encourage the scientific community to recognize this unique approach as a leading concept in the fight against hunger in developing countries.

(iii) Adapt the new concept for developed countries: An intriguing and important question about the new food scheme concept introduced in this study is whether it can be applied to the problem of hunger in developed countries. In developed countries, many people suffer from hunger, and over the years, this has become even worse. The problem of hunger in developed countries has its own nature, one different from that of developing countries. In developed countries, hunger is a socioeconomic government policy problem that is linked to poverty, unemployment, and other social factors (I. Nyambayo, 2015). Therefore, in this case, the model offered in any new study could be constructed based on social and economic indicators, thus presenting a new policy model to fight hunger in developed countries. These indicators could

define two status levels to those who are considered by a government as being in a position of hunger. Such indicators could include age, marital status, income source, number of persons in the family unit, ethnicity, and so on.

5.5 Discussion, conclusions, and recommendations

This section focuses on the following topics: *(i) Discussion of the various results presented in Figure 8–Figure 12,*
(ii) The introduction of this thesis's new concept for solving hunger, (iii) Economic theories supporting this study's analytical findings; and *(iv) Discussion on achieving this thesis's goals and hypothesis*.

(i) Discussion of the various results presented in Figure 8-Figure 12

Positive progress in the GHI score and its four component outcomes is reflected by various hunger programs that have been presented in different research studies. In our case, the effect of time was observed, but in this study's sample, the countries were characterized by the high or low use of hunger model criteria. The change over time for each outcome was therefore found to be dependent upon the intensity of criteria used in the hunger-management model, as shown in Figure 8-Figure 12.

The prevalence of undernourishment is the FAO's main hunger indicator. It measures the portion of the population that has an insufficient calorific intake to meet individual needs. According to FAO data, the prevalence of undernourishment in the different regions of developing countries (i.e., those with the greatest share of undernourished people) has significantly decreased over the years. In 1991, 18.6% of the population were undernourished, but this dropped to 10.8% in 2015, about a 42% decrease (Roser & Ritchie, 2018).

For all the countries in this study's sample (i.e., regardless of the use of hunger model criteria), there was a significant decrease in the proportion of undernourished in the population. In 1992, 32.17% of the population was undernourished, but this fell by about 40% to 19.45% in 2016. This result supports the trend reported in the research literature, such as in Roser and Ritchie's (2018) study. Lack of significant interaction between time and hungry model stresses

the stability of hungry model over time, that is, in all time measurement points, using many criteria of hunger strategy indeed succeed to obtain positive results.

The proportion of under-fives across the world's regions who are defined as underweight for their age has been documented since 1990. There has been a steady decline in the global level, with it falling from around 25% in 1990 to 15% in 2015 (Roser & Ritchie, 2018).

However, the nature of wasting is often exemplified by rapid weight loss, which means that short-term events that affect food supplies can disrupt the long-term trends. This is particularly likely in politically unstable countries. For example, there was a large spike in childhood wasting in the Democratic Republic of Congo during the late 1990s and early 2000s, during the Second Congo War (Roser & Ritchie, 2018).

In our study, as shown in Figure 9, there were two spikes in childhood wasting for countries with both the high use and low use of hunger model criteria, and these can be explained by the impact of different events on the food supply. This could lead to the conclusion that while a generally positive trend is observed, the appearance of spikes in childhood wasting may suggest that a longer follow-up is required. In other words, the change in the prevalence of wasting seems to be a long-term process that needs long-term observation.

Data for the prevalence of childhood stunting in under-fives is often not available on an annual basis. Despite this, the FAO's data for different countries shows significant differences across all years with a decreasing trend. For example, Bangladesh had stunting problems in 71.1% of under-fives in 1983, but this dropped to 36.4% in 2014. For Kenya, it was 41.6% in 1978 but fell to 26% in 2014 (Roser & Ritchie, 2018).

In our study model, in countries with both high use and low use of hunger model criteria, a significant decrease was seen in the prevalence of stunting in under-fives. In 1992, the rate of stunting was 38.37%, but this dropped to 26.23% in 2016. This mirrors the trend reported by Roser and Ritchie (2018). Moreover, Figure 10 shows that for countries that apply a high use of hunger model criteria, the downward trend has halted. This could be a localized phenomenon or some lower barrier related to this situation. In any case, it warrants further investigation.

The global under-five mortality rate[94] is falling faster than at any other time in the past two decades. All regions, except for sub-Saharan Africa and Oceania,[95] have reduced their under-

[94] The under-five mortality is rate per 1,000 live births.

[95] There are 14 countries in Oceania.

five mortality rates by 52% or more. The global annual rate of reduction has steadily accelerated since the 1990–1995 period, more than tripling from 1.2% to 4.0% over the 2005–2013 period (UNICEF, 2014).

For all the countries in this study's sample (i.e., regardless of the high use or low use of hunger model criteria), the same trend as presented by UNICEF in 2014 was also observed. In our study's case, there was a significant decrease in the prevalence of child mortality between 1992 and 2016, dropping from 9.14% to 4.11%, a reduction of about 55%.

Tracking progress in GHI scores over time, we see definite improvements in all regions. In 1992, most countries across sub-Saharan Africa and South Asia fell within the "extremely alarming" or "alarming" classification. By 2016, no countries remained in the "extremely alarming" category, and most have been downgraded to the "serious" category. In other regions, countries have generally shifted from "moderate-to-serious" in 1992 to "low-to-moderate" in 2016. For example, in 1992, Pakistan's GHI score was 43.4, but this dropped to 32.6 in 2017. Bangladesh, meanwhile, had a GHI score of 52.4 in 1992, but in 2017, it was just 26.5 (M. Roser and H. Ritchie, 2018).

For all countries in this study (i.e., regardless of the high or low use of hunger model criteria), a significant decrease was observed in the hunger score between 1992 and 2016, with it dropping from 34.40 to 21.06. This noticeable improvement was also presented in Roser and Ritchie's (2018) study.

Moderation effect: This study found it important to confirm whether any additional variable had a moderating effect on the relationship between the two variables examined (i.e., hunger models and outcomes). It did this to examine whether the nature of this relationship changes as the values of certain moderating variables change, namely the Corruption Index, the Human Development Index, Government Effectiveness, and Political Stability. Examining the moderating effect of each moderator on the relationship between the hunger models and each of the four outcomes did not reveal any significant interactions, meaning that these indices do not influence hungry outcome in combine with hungry model. In other words, using many criteria of hungry model is the most important predictor for positive hunger indices, and no other indicators.

http://www.worldometers.info/geography/how-many-countries-in-oceania/

This could be explained by the possibility that other factors and variables may be bringing about a different result. In this study's case, the different moderators are not simple indicators but rather complex indicators based on several simple indexes,[96] each of which is weighted differently according to its estimated importance. This fact may have influenced the results of the moderation effect analysis. Our recommendation is to therefore try simple indexes as moderators for any similar analysis in future.

(ii) Introduce a new concept to solve hunger

This study highlights two important points about fighting hunger fighting in developing countries:

Countries' behavior to address the hunger problem: Different hunger policies are promoted by various organizations and agencies to address the hunger problem in developing countries. In different cases, developing countries implement a program partially or fully. In other words, not all countries apply all of a hunger program's criteria, which reflects on how different countries improve their hunger level over time.

The nature of the hunger solution: The basic approach of the major programs in the research literature does not show any consideration for development level. These policies mostly offer several criteria that are usually based on various research works undertook by leading big organizations like the FAO. These studies attempt to find the reason for hunger and formulate policies to address them. For example, the FAO's study in 2011 points out that hunger is a food insecurity problem, and it principally results from three basic causes: (a) low productivity in agriculture, frequently caused by unsuitable policies and institutional and technological constraints; (b) seasonal influences on food supplies; and (c) a lack of off-farm employment opportunities in rural areas (FAO, 2011). Therefore, FAO policies focus on improving nations' food security through rapid increases in their food production and productivity, as well as improvements in people's access to food (E. E. Dooley, 2004). It happens that developing

[96] The HDI is a summary measurement of average achievement in the key dimensions of human development. It combines three dimensions. The Political Stability Index is a composite measure, as it is based on several other indexes from multiple sources. Government Effectiveness is an index combining up to 15 different assessments and surveys. Each of these indicators depends on availability, and each factor receives a different weight and depends on its estimated precision and country coverage.

countries have their own considerations when adapting part or whole of a package of hunger solution criteria, and this may reflect in their progress in reducing the GHI level and other indicators. It should be emphasized again, however, that these hunger polices with their various criteria do not represent the concept of fitting hunger solutions with a country's development level.

These two insights concern **countries' behaviors to address the hunger problem and the nature of the hunger solution**, but it is time to introduce a new and unique hunger solution model. This original hunger-management model comprises an effective combination of existing solutions for countries at differing levels of development.

The following results concern the relationship between hunger-management models and the level of hunger over time:

1) As clearly reflected in the five figures (Figures 8–12), countries with a high and low use of hunger model criteria show different progresses in their hunger level over time.
2) Two different behaviors from developing countries to fight hunger were evident. Countries with an initially more problematic situation (i.e., higher values in the five indicators),[97] chose simpler and more focused outlines to address their hunger problems (i.e., low use of hunger model criteria). In contrast, countries with an initially less severe condition, according to the five indicators, chose broader programs (i.e., high use of hunger model criteria) to solve their hunger problems.
3) Both tracks presented positive effects over time. In other words, there was a significant decrease in the hunger level over time and for each examined outcome/indicator.

Based on the above three very important insights, this study presents a new working plan for developing countries when making decisions about the fight against hunger. This involves applying well-fitted hunger solutions for countries at different development levels to achieve a more effective and controlled solution for the hunger problem in developing countries (Table 30). More specifically, this hunger solution is based on an original hunger-management model that comprises an effective combination of existing solutions for countries at different development levels. It is a tailored hunger solution based on two modes for hunger model criteria, namely the

[97] **The five indicators**: the proportion of undernourished people in the population (%); the prevalence of wasting in children under five years old (%); the prevalence of stunting in children under five years old (%); the under-five mortality rate (%); and the GHI score

high use of hunger model criteria and the low use of hunger model criteria, in order to link a hunger-management model with the country's development level. This unique tool takes the approach of fighting hunger in a more focused way. In addition, this solution presents a dynamic program that seeks to maximize the positive effect over time in terms of the GHI score and other indicators. The working plan for countries with different development level consist of the following premises:

(1) Developing countries with a poorer initial condition (i.e., the more problematic countries, as represented by the GHI and its four component indicators) are advised to choose a simpler and more focused program to address their hunger problems (i.e., apply the low use of hunger model criteria). This leads to more effective results in reducing the hunger level over time.

(2) Countries with a better initial condition (i.e., the less problematic countries, as reflected in the GHI score and its four component indicators) are advised to apply a broader program to overcome their hunger problems (i.e., apply the high use of hunger model criteria).

(3) Countries that already apply the low use of hunger model criteria should look to move to a more extended format (i.e., switch to the high use of hunger model criteria) after several years. They can then expect to benefit from continuing reductions in the hunger level and its four indices.

(4) Countries that already apply the high use of hunger model criteria should look to extend their format even more in order to accelerate and improve reductions in all indicators and move toward completely solving their hunger problems and achieving the Millennium Goal 2.

Table 30: The hunger-solution program: a new unique hunger solution based on an original hunger-management model

Country Character	**Country performances**									
	Indicator means (over 1992-2016)					**Hunger-management criteria used**				
	General Hunger Score	Prevalence of mortality (%)	Prevalence of Stunting (%)	Prevalence of Wasting (%)	Prevalence Of Undernourishment (%)	High use	Low use	Time effect	Recommendation (next step)	Expected time effect
Less problematic countries	21.2	4.6	26.5	5.1	22.5	X		Positive effect	To apply a broader program in their hunger-management model criteria	Achieving MG2 hunger goals
More problematic countries	36.5	8.7	29.0	9.5	27.7		X	Positive effect	To move to a more extended format in hunger-management model criteria	A significant improvement in hunger level and all hunger indicators

Source: Own elaboration

(iii) Economic theories supporting this study's analytical findings

Two economic theories, namely *the regional development theory* and *the public choice theory*, make a significant contribution to this study's discussion by linking between governmental institutions' decision-making and development. These play an important role in reducing poverty and the hunger level in developing countries.

Both of these theories provide good explanations for the observed tendencies of the hunger level and its various indicators/outcomes, as presented in Figure 8–Figure 12, and they also support this study's proposed solution to the hunger problem in developing countries.

Regional development theory points out how the objective of development is to raise people's living standards, emphasizing that development occurs in different socioeconomic environments and takes different forms at both national and regional levels. These two factors are

influenced by various parameters, including a country's socioeconomic performances, which in turn lead to different levels of regional and national development (M. Sankaran, 2015).

When performance is unsatisfactory or weak, intervention is required at both regional and community levels. It is therefore necessary to formulate policies for each region in order to ensure good performance for the national economy (B. H. D. J. Savoie, 2017). Such insights and understanding support this study's basic concept of tailoring hunger solutions to a specific country's development level. This ensures, as well as maximizes, improvement in the different country indicators and achieves better progress in the GHI score.

Moreover, regional development theories refer to change in a desirable direction and at an appropriate speed. The direction and rate of change then depend upon the goals and objectives of the proposed development (B. H. D. J. Savoie, 2017). This theory therefore explains the various tendencies presented in Figure 8-Figure 12. More specifically, it explains why countries that implement the high use of hunger model criteria (i.e., countries with wider goals and objectives for development) show greater rates of change over time in their GHI scores and other indicator values. In other words, countries applying the high use of hunger model criteria generally show a better developmental performance, as expressed indirectly by progress in their hunger score over time.

Regional development theory emphasizes the importance of institutions and other bodies in promoting development at a territorial level. Promoting development depends on whether political decision-making results in outcomes that conflict with the preferences of the general public (D. Antonescu, 2012). In this field of interest comes the *public choice theory*. This theory recognizes that politicians are often motivated out of self-interest, so they sometimes do not meet the real needs of a country and its people (F. Eryilmaz, 2015). Thus, public choice theory highlights how government failures are associated with a lack of economic efficiency, specifically from economic decisions and unfair income distribution. Such poor economic efficiency can be seen resulting from government corruption in developing countries, and this influences these countries' economic and social performance. This, in a way, inhibits any reduction in the hunger level.

In addition, according to A. Drazen (2006), policy failures can often be understood in the context of the political economy of policy choice. The failure of some developing countries to grow could be related to policy choices, both by the governments of those countries and external

decision-makers. These policies may be designed to serve special interests that may and benefit a small elite (D. A. Rondinelli et al., 1989). The expectation is that achieving better standards of living and to reducing hunger problem needs a different way of thinking, which this study's solution provides.

Public choice theory points out that government policy choices could explain why this study reveals two different performances for countries in reducing their hunger scores and each outcome over time. It concerns government choices when fighting hunger. The better a government's policy choices are, the better the results will be in terms of improving the GHI score and other indicators over time. For example, governments that choose the low use of hunger model criteria to fight hunger tend to show lower performances over time in reducing hunger and its outcomes.

In summary:

- These two economic theories (*regional development* and *public choice theory*) point out that (i) formulating policies for each region is needed for better economic development and (ii) the way governmental institutions make decisions reflects directly on economic development and indirectly on progress in reducing hunger over time.
- These two theories also provide good support for this study's finding that applying the high use of hunger model criteria leads to better progress in reducing hunger over time. Moreover, the *regional development theory* emphasizes the need to tailor policies to fit regional performances and bring better economic development, which in turn helps to reduce hunger.

(iv) Main findings

This chapter introduced an original hunger-management model concept (or food scheme model) that comprises an effective combination of existing solutions for countries at different development levels. It represents a new tool to fight hunger in developing countries based on the statistical relationship between a hunger-management model and the level of hunger. For this purpose, this study defines two types of hunger-management model, which was used as the independent variable: "the low use of hunger model criteria" and "the high use of hunger model

criteria." Repeated measures ANOVAs were conducted for several representative years for the general GHI score and its component indicators.

The following main findings were derived:

1. For all countries in the sample, significant decreases were seen for each of these outcomes: proportion of undernourished in population, prevalence of stunting in children under five years, prevalence of children mortality, and the general hunger score.

2. Significant differences were seen across all years between country groups. Countries that apply the high use of hunger model criteria showed lower values for each hunger outcome, as well as significantly lower general hunger scores. To conclude this important finding of this thesis, we conducted Repeated measures ANOVA following with Bonferoni post-hoc analyses in order to interpret the results of the ANOVA. Results of post-hoc analyses showed that countries that apply high use of hunger criteria have better patterns of outcomes in comparison with countries with low use of hunger model criteria. These results were obtained by comparing averages of each outcome between countries-groups after Bonferoni corrections. Specifically, results showed that countries that apply high use of hunger criteria have lower proportion of undernourished in population, lower prevalence of wasting in children under five years, lower prevalence of stunting in children under five years and lower mortality rates of under five. Analysis holds high statistical power since it examined the hypotheses using ANOVA, and then Bonfeorni post-hoc which strength the findings.

3. Moderation effects were examined using repeated measures ANOVAs with covariance. Four moderators were examined: the Corruption Index, the Human Development Index, Government Effectiveness, and Political Stability. Examining the moderating effect of each of these moderators on the relationship between hunger-management models and specific outcomes did not reveal any significant interactions. Moderation analyses test interactions using repeated measures ANOVAs with the following additional variables: Corruption Index, Human Development Index, Government Effectiveness, and Political Stability. Findings indicate that these variables splitting the data using these variables (for example countries with low versus high corruption Index) do not create new and significant patterns of hunger outcomes. The insignificant results are probably due to high variance of each variable which made it difficult to detect significant moderation effects.

4. This study presents a new working plan for making decisions to apply an effective and well-fitting program for countries at different development levels, as presented in Table 30. Such a working plan has three characteristics. **First**, it maximizes the positive effect over time on the general hunger score, as well as its component indicators. **Second**, it is a dynamic program that develops over time in accordance with a country's progress in the various indicators. **Third**, it represents an effective and controlled way to fight hunger, and it could be considered as a thinking-outside-the-box solution that is new to the research literature.

5. This chapter examined the relationship between a chosen hunger-management model and the level of hunger, which can be observed in Figure 12. The two graph lines in this figure point out the direct relationship between a chosen hunger-management model and the level of hunger over time, providing supporting evidence for the relationship, as indicated in this study's first goal.

6. This study also verified the second goal, namely that a food scheme can serve as a tool to achieve a better solution for the hunger problem in developing countries. This is clearly reflected in Figure 12, which shows significantly better progress across all years for countries that apply the high use of hunger model criteria when compared to those that apply the low use of hunger model criteria.

7. This research's findings support this study's hypothesis about a direct relationship between the hunger-management model and the level of hunger in developing countries. Developing countries applying the high use of criteria in their hunger-management models demonstrate better progress in reducing their levels of hunger than those applying the low use of hunger model criteria, thus verifying this study's hypothesis.

Summary

The problem of hunger is one of vast proportions, and it mainly manifests in developing countries. It affects the millions of people who struggle to obtain and eat enough suitable food on a daily basis. While this problem has local implications at the social and economic levels, it has cross-border effects too. Various organizations and agencies recognize it as a global problem, and they are motivated to find a solution, not just from a moral aspect. The basic commonly accepted understanding of hunger is that it is mainly a product of food deficiency and food insecurity in its different facets. Therefore, most of the programs presented in the research literature to address the hunger problem in developing countries offer various means of bolstering food security at different levels. Some leading programs originate from the FAO, such as the FAO Twin Track and the FAO Special Program for Food Security (SPFS).

Over the years, the level of hunger has been reduced in developing countries, and there is no doubt that the various programs have made an important contribution to this achievement. However, researchers, as well as governments and agencies, cannot ignore the fact that millions of hungry people still lack the physical and/or economic access to sufficient, safe, and nutritious food to meet their dietary needs. It can therefore be concluded that there has been some fundamental shortcoming in the concepts of the various programs, because their basic approaches seem to encounter difficulty in comprehensively ending hunger once and for all. Considering this background, there appears to be an urgent need to find a new approach to fighting hunger. Moreover, gaining a better understanding of how to address the hunger problem will help to achieve better progress in GHI scores over time. This study takes a first step in this direction by suggesting a new approach to fighting hunger where a country's developmental level is considered to be an important factor when addressing the hunger problem. This essentially involves tailoring a hunger solution (i.e., a *hunger-management model or food scheme*) to suit a particular country's level of development. No attempts at such an approach have so far been documented in the research literature. This new approach considers the linkage between a country's level of hunger and its developmental level, thus helping to gain a better understanding of the influence of a country's *hunger-management model* on its level of hunger.

Such an approach:

(1) serves local government, decision-makers, and various global organizations (i.e., anyone expending resources in this matter) by helping them to achieve better progress over time, as well as giving them more control over the process, when addressing the level of hunger; and
(2) gives the various decision-makers a new dynamic working plan for generating more focused solutions that fit with local and global economic and social changes over time.

This research aims to fill a gap in our research knowledge about the relationship between a developing country's *hunger-management model* and its level of hunger. In addition, it seeks to translate this new knowledge into a new and unique tool for developing a hunger solution model.

This study takes the following five steps to fill this gap in our knowledge. First, it introduces the concepts of hunger, poverty, inequality, and welfare from the perspective of historical economic thinking. It highlights how poverty is a central concept in economic theories, one that is inextricably bound with inequality and hunger. In addition, major economic theories point out that market behavior is the main reason for hunger (see Chapter 1). Second, it discusses two points of interest about hunger: (i) hunger in the modern world has local and global consequences; and (ii) countries with a hunger problem are characterized by a common socio-economic profile (see Chapter 2). Third, this study introduces the concept of food security, which is the basis for many different hunger solutions and working plans. These solutions take one of two different approaches: one based on the assumption that hunger in developing countries is about food deficiency (the one-dimensional hunger-solution model) and another one based on the assumption that world hunger is about an inability to get food to those who need it (Multi-dimensional hunger solution model) (see Chapter 3). Fourth, the study gives insights into a new *hunger-management model* concept from two points of interest:

(1) as an original approach for developing hunger-management models (i.e., food scheme) that effectively combine existing solutions for countries at different developmental levels; and
(2) the importance of this novel approach for (i) tailoring a hunger program to fit a country's developmental level in order to more effectively address hunger, (ii) tracking and analyzing countries' achievements under different policies over time, and (iii) helping to gain new insights that may support future decision-making (see Chapter 4).

The fifth step involves a data analysis based on repeated ANOVAs statistical analysis. This statistical tool tests the relationships between the model used by countries to address hunger and their level of hunger over time. The two hunger models considered in this study are the "low use of hunger criteria" and the "high use of hunger criteria" (see Chapter 5). In addition, the fifth step deals with two subjects of interest: (i) interpreting the results and (ii) presenting relevant economic theories. Two different behavioral approaches to fighting hunger were evident: Countries with an initially more problematic situation apply fewer criteria in their hunger models, while countries facing a less severe condition prefer broader programs to address their hunger problems. However, both approaches have positive effects over time in terms of significantly decreasing the examined indicators. The results verified this thesis's hypothesis that there is a direct relationship between the *hunger-management model* and the level of hunger in developing countries. Based on the data analysis and interpretation, this study proposes a new type of solution to the hunger problem based on developing *hunger-management models* that suit a country's problem and level of development. In addition, *the theory of regional development* (theory I) *and the public choice theory* (theory II) are two economic theories that are very relevant to this study's discussion. These theories support the notion of tailoring ideas and emphasizing government decisions as a motivating force for development (see Chapter 5).

The proposed approach for developing hunger solutions in this study does not consider the hunger problem in developed countries, because this would need a radically different examination of their hunger problems and require the identification of country indicators that are relevant to hunger-management criteria. Indeed, the hunger problem in developed countries has its own unique nature and causes, and it is mainly economic policies that make it harder for people to access food.

When it comes to the suggestions for further research the study develops a new *hunger-management modelling* concept for reducing the hunger level in developing countries. This is a new concept that has so far not been reported in the research literature and it therefore warrants additional investigative work:

(i) *Extend the research to other regions and countries*: Such an extended study could reinforce the findings of this research, and this could encourage the scientific community to recognize this unique approach as a leading concept in the fight against hunger in developing countries.

(ii) *Region-based hunger criteria:* Hunger-management models developed for regions with unique natures could help to gain a better understanding of the link between a *hunger-management model* and the level of hunger, as well as improve those countries' progress in reducing their level of hunger.

(iii) *Adapt the new concept for developed countries*: An intriguing aspect of the new *hunger-management modelling* concept introduced in this study concerns whether it can be applied to the problem of hunger in developed countries, which has its own nature in that it stems from socioeconomic government policies linked to poverty, unemployment, and other social factors (I. Nyambayo, 2015). For example, the *hunger-management models* of developed countries could be based on socioeconomic indicators.

The above suggested research areas could play an important role in understanding the hunger problem in all its complexity and help to find better solutions. Such fresh knowledge could lead to new conclusions being drawn, thus improving the solutions offered and supporting future decision-making. The further studies could encourage the scientific community to recognize this new approach as a promising and unique concept for fighting hunger in both developing and developed countries.

In conclusion, this study presents a unique approach for developing original *hunger management models* that effectively combine existing solutions for countries at different levels of development. Moreover, this study presents a new working plan for making decisions to apply an effective and well-fitting program for countries at different development levels. Such a working plan has three characteristics: It maximizes the positive effect over time on the general hunger score, as well as its component indicators, and it is a dynamic program that develops over time in accordance with a country's progress in the various indicators. It is also a unique tool that takes the approach of fighting hunger in a more focused and controlled way, and as such, it can be considered as outside-the-box thinking that is new to the research literature.

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