Science Meets Reality:
Economic Efficiency, Markets, Institutions and Food Security

Bernardo Reynolds Pacheco de Carvalho
University of Lisbon , Portugal
bpacheco@isa.utl.pt

Summary

Food still is, and will continue to be, a basic issue at every day decision process in human behavior. Food consumption has been a problematic issue in human history and today is also recognized as a basic pilar for human health and welfare/quality of life. From a global problem up to the middle of the eighties, right now food security is mainly a local issue (however a macro-level approach continued to be necessary for long run perspective and food safety concerns in trade and commercialization). Food and nutritional concerns today still are unforgetable issues on a local base perspective in many regions: the most common problems are related to the access and consumption to achieve the minimum nutritional requirements, but also other dimension such as production, transformation, distribution and logistic aspects of the "food equation", mainly in less developed countries, are crucial aspects to be taken into consideration.

Economic effciency from a production perspective in the food sector, measured in terms of output per unit of input (technical and technologial innovation) achieved one of the best performances in terms of development in the last 30 years. The same can not be refered in regard to markets and institutional innovations. In fact, looking at institutions including markets and governments, it is necessary to explore and identify the several observed failures (institutional and governance failures: markets, governmental and others) were science can make a contribution. This is the main purpose of the current research, which is starting based on observed problems and applied solutions with good results in many situations, but also pointing out many other situations were solutions are needed based on the old instruments, but also based on innovative procedures. The methodoly followed explores the basic theorectical approach in production theory and in consumption micro-economic concepts, allowing the introduction of some new purposals in regard to efficiency measures. Adding to those aspects some new questions and models are discussed in regard to the "institutional/organizational economics" in the actual world, providing support for improvement measures (and policy suggestions).

The Brasilien case is explored in more detail (the "Fome Zero Program"), but also some african examples are used to ilustrate that many solutions will have to rely on technological changes, but also on institutional innovations.

Keywords: *Food Security, Good Governance, Economic Efficiency, Institutional and Market* Efficiency

1 Introduction

The Scientific contribution to our actual world and conditions of life is a central pillar of the occidental civilization. However values, paradigms, structural models and different philosophic approaches to understand men´s situation and the Universe around us, (where we are, as human kind, and which vision we have from ourselves), have been always crucial to understand the society and its changes through time. Science and knowledge, specifically through technological tools, is the main driver of the economic

growth with tremendous output potential and real growth in production in the last century. In many areas of human needs and consumption, the production leverage for better lives was dominant, that is, supply driven economies were the most common and successful economies in growth and development.

Today is quite clear that quality of live and development cannot be guaranteed only with higher consumption rates. It is necessary to look at least to other issues such as sustainability, social and environmental dimensions. In the food system those aspects are always present. From a deep crisis in food supply, almost permanent up to the seventies (1970´s), a different paradigm is now in place with the world characterized in the last 20-30 years with global surplus. However hunger persists, and has been mainly a local/regional dilemma without any improvements in the last 10-20 years, in absolute terms and/or in relative terms (Carvalho et al 2011).

Science, and the all set of professionals in different areas related to the food systems cannot avoid the responsibility to try solutions and find out the way out of this challenging and chocking situation.

2 Background and Objectives

Social sciences and specifically economic development studies in the food system should be central to all discussions about solving hunger and improve quality of live of millions of human beings, mainly in tropical and subtropical regions, were production potential is usually there and it is not the main constraint for development. Other dimensions need to be addressed, and special attention will be given to the organizational aspects of the human behavior in our society. The present main objective is to contribute to point out solutions and a framework for actions and policy able to make a “difference” and significant impact in the “food security equation “around the world. From a theoretical perspective and discussion the author will also present and discuss real cases and examples that can be explored, rationalized and better understood based on the framework introduced.

To help the reader it is provided a sequential list of several inter-related topics that will be presented and discussed along the work, including:

1 – Production Efficiency
2 – Consumption Efficiency
3 – Governance – Governmental Actions
- Governability Infrastructure and framework
- Systems Governance

4 – Markets Efficiency.
5- Failures: Markets failure, governance and institutional failures.
6 – Modelling proposals and Economic Rational at Macro and Micro levels: Induced Innovation and Structural Changes with the WFSE –world food security equation model.
7 – Referencial facts and data
8 –.Discussions, Empirical Results with case studies and Conclusion

Not all of this list of issues can be discussed at the same level, because of space and time limits, but all are relevant for present and future attention. With all the discussion and methodological considerations about different efficiency concerns, data is also selected and analyzed such that the hypothesis raised will be tested and conclusions derived aiming to provide policy support for future interventions in the food system dynamics. The Brazilian case is explored, mainly the "Fome Zero Progam," but also success examples in African are also used to support the arguments presented.

3 Procedures and methodology.

Following the list of topics presented above, relevant to promote a new framework to solve and test our main hypothesis, this article is a starting exercise to promote discussion and a new way to think about old problems such as persistent hunger and lack of food security.

The main hypothesis can be described as follows:

a) Production technology in the food sector has been successful and able to overcome the demand increases;
b) Demand behavior needs to change, incorporating better knowledge and decision process, with overall growing efficiency.
c) There is an enormous potential for growth, natural resources availability, including human and labor factors, but good governance is missing, which includes several problems such as deficient Governmental actions and Public policy, lack of efficient Institutions, and others failures (such as market failure, leadership and/or organizational problems);
d) Demand driven economy is dominant in the food system, and demand constraints are key aspects to be overcome.
e) Food security concept is relevant to solve hunger problems, which needs a multidimensional approach, dealing with markets (production and consumption), institutions and governance dimensions.

Production Efficiency

Production definition and technical considerations about economic efficiency in production is a starting point. Production is any activity able to create value, starting with more than one input and using any combination of factors with a defined manner and objectives, based on present and/or future assets to add value to the system with tangible and/or intangible goods and services. This definition based on Willis Peterson (1986, pp 89) most simpler definition – "production can be defined as any activity that creates present and/or future utility" is a bit more elaborated, incorporating the need to define a certain technology, meaning combination of resources within a certain sequence of actions, an objective and the possibility to have some mathematical relationship defining those issues. Most of the time "production" will be represented by a function Y = f (x1, x2…..xn), where relationships among inputs and among inputs and output are defined. Note that multiple outputs are usually not considered, and when present treated as externalities.

Efficiency concerns in “production” within the food systems have been studied from different perspectives, from technical/Engineer point of view and from Economic point of view. Today those different approaches work together and are not differentiated in general, meaning that both perspectives should be present. However it is useful to differentiate technical efficiency and economic efficiency in our choice set and possible solutions from the producer point of view. Technical efficiency means to obtain the maximum output for a given quantity of available inputs and/or achieve a/for certain level of output with the minimum input level.

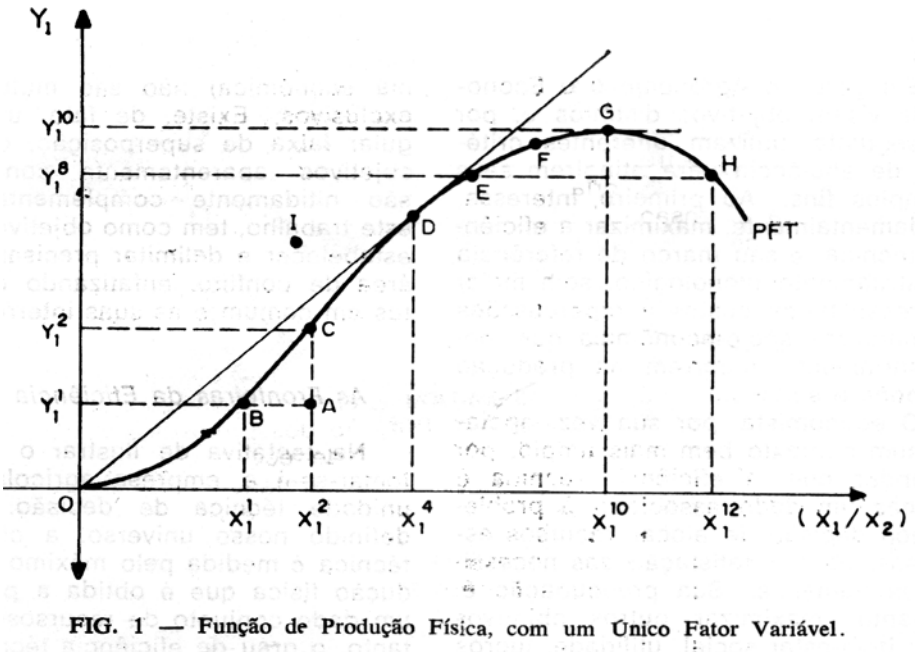

FIG. 1 — Função de Produção Física, com um Único Fator Variável.

Figure 1. Production Function: one input x1, given a set of fixed inputs x2, to produce Y.

It is helpful to recall the basic production function graph, to show that technical efficiency criteria helps the decision process, with reference to a production unit, in the sense of providing a set of possible choices much smaller than the original “universe” of possible choices, but do not provide a unique solution. In the graph above it is evident that technical efficient criteria is between point “D” and point “G”, defining a zone/frontier of technical efficient choices. Note that point “D” is the Maximum Physical Mean, and Point “G” the maximum physical solution. It is necessary to add the economic efficiency criteria to solve the “problem” for the best solution in terms of maximizing profit/excess value creation/economic surplus. Economic efficiency means to add the relationships between prices and respective ratios, output/input prices and input/input prices. Assuming a monetized economy, everything can be expressed in money references and the economic surplus in profit units. For continuous relationships, there is a unique solution for Economic Efficiency, which is also a “point” with technical efficiency in the frontier of technical efficient solutions. It is defined as the “point” able to maximize economic surplus/profit.

Many other forms can be explored to show the economic and technical optimizing solutions beyond input/output relationships, basically recalling other relations in the input/input space (isoquants relations), output/output relations and prices for inputs and

outputs, specially represented in the supply functions. It is not the time and opportunity to review this well known theory, but the actual introduction shows that from the production perspective, technical efficiency is a very precise issue where quantification and mathematical solutions are possible.

Consumption Efficiency

From the consumption point of view, efficiency considerations and analysis can be made, but this concept and concern is certainly less present in the "mainstream economics" than is the efficiency considerations in production economics framework. We can use an Utility function U= f(y1….ym) in a similar way to the production theory, and establish the necessary conditions for a maximum and for an efficient solution in consumption. However, a set of limitations are present, starting with the fact that it is not possible to measure "utility" in cardinal way. That is, in real world, only the revealed preferences can be used to derive an ordering of preferences, which can produce the base for some type of quantification, but, again, for ordinal measurements. Demand functions are derived theoretically, but for empirical use and estimations it is necessary to use the revealed preferences and consumption behavior in the Markets.

Other limitations can also be pointed out in usual consumption analysis, such as the Utility monotonic growing conditions in each variable, that is: Utility is assumed to be always growing with more consumption, meaning dU/dyi> 0 for all range in the domain of yi.

However, much of the production type of analysis can be applied, with some adaptations. Indeed, some authors (Carvalho 1998, Lee et al 2005 and others) have used this approach. Today, it is useful to recall the previous work (Carvalho 1998) based on Lancaster´s (1966) perspective, in the sense of defining "Consumption Technology" in a similar way to "Production Technology" which will allow to study the efficiency in the consumers choices. The idea is to consider Consumption as a transformation process, using inputs (consumption products – goods and services) in a certain combination to obtain desired "characteristics" with equivalent value in terms of utility production. This exercise allow to consider that Utility can be measured in cardinal terms, at least in relation to those "characteristics" and consumption of products can be transformed into characteristics consumption, plus a specific factor for each product consumed with some specific, non comparable characteristics. In fact it is possible to have a two step approach, leaving some space for specific factors in some consumed products, or on the limit transform any commodity into some type of "common characteristics" to which we can associate a certain value for the consumer.

The studies in food systems and consumption is an example where this approach can produce useful analysis, mainly when it is necessary to guarantee a minimum level of nutritional conditions for human health conditions. The "consumption technology" now is obtained looking at the transformation technical coefficients, such that from products obtained in the market the objective is to satisfy the maximization of "producing Characteristics." With this approach any new product entering into the market can be studied and analyzed in terms of the contribution for each "characteristic" in the Utility

function, and evaluated in terms of economic efficiency and contribution for consumption efficiency.

The next step now will be centered in the information and knowledge needed about the characteristics we can find in each commodity and immediately to evaluate the consumer behavior in regard to his capacity to take the most correct decision, at least in terms of the defined "common characteristics" and prices/cost. This exercise was performed in several conditions and specifically by the author to study consumer choices in food and in regard to traditional products, new alternatives and possibilities to improve nutritional status and welfare, only through better consumption choices (and consumption efficiency).

Governance and Governance Efficiency

The previous comments point out that efficiency concerns in consumption are almost absent in the "mainstream economics" (also, for example, Apichai Puntasen, 2013). However it is there and several work efforts were done, but a lot need to be pursued in the next future. In regard to Governance and Governance Efficiency, those issues are entering into discussion and are being used increasingly in development literature. At this point it is useful to introduce the discussion, mainly as a starting effort to evaluate the contribution of the scientific work in those matters and basically point out opportunities for further contributions in the next future centered in the food system.

Governance as a concept itself is not new, in the sense that it can be defined, within a society environment**, as the process of decision making and the process by which decisions are implemented**. This concept is always associated with a system perspective and with the process of making decisions and how they are implemented within a set of actors/agents in a dynamic perspective and with interactions among them. From an individual and singular entity taking and implementing decisions, consumer decisions, firms and businesses, singular economic units universe, governance issues are related with multiple actors and most of the time connected with collective actions. Governance concerns have been in place within many different perspectives, such as corporate governance, international governance, national governance, local governance and related with any specific social group process of making and implementing decisions (mainly collective decisions and/or with collective impact) to manage the system in which they are involved.

Indeed, Governance is about how a social group manages itself in a changing world where decisions and actions are necessary to face common challenges. Immediate connections with the New Institutional Economics (NIE) perspective are obvious. This body of research and literature, which main reference is Olivier Williamson (1975) has been growing in importance, but the same author in 2000, start it´s article (Journal of Economic Literature) saying a) "….we are still very ignorant about institutions,"; b) "…the past quarter century has witnessed enormous progress in the study of institution" and c) " …awaiting a unified theory we should be accepting of pluralism."

Accepting those comments still valid today, it is useful to start with the basics, defining institutions. Using our advisor definition Ruttan (1985), "institutions are the rules of a

society or of organizations that facilitate coordination among people by helping them form expectations which each person can reasonable hold in dealing with others. They reflect the conventions that have evolved in different societies regarding the behavior of individuals and groups relative to their own behavior and the behavior of others" This is a broad and more inclusive definition, without making the difference between institution and organizations, like Douglas North´s demarcation with "institutions" meaning "rules of the game" with both formal and informal rules and norms that help to govern individual behavior and structure social interactions (institutional framework). Organizations are those groups of people and the governance arrangements they create to coordinate their team action.

Without entering into deeper discussion, it seems reasonable to thing about organizations as smaller entities, and about institutions as a more general and global perspective, but both are important structures for systems governance, but clearly not enough. Markets can be seen as institutions but also as a "natural phenomena." Governments are certainly based on organizations and institutional framework, and can be seen as an institution itself. However it seems also reasonable to look at Governments as a specific component of our society, with the first responsibility to deal with the common interests and public goods.

Many contributions have been made under this NIE approach, many of this under several well known areas such as transaction costs, asymmetric information, strategic behavior, bounded rationality, human assets, social capital, adverse selection, moral hazard, contractual safeguards, bargaining strength, etc. In the NIE analyses the work is within a Neoclassic framework and both efficiency and distribution issues are present.

It is necessary to recognize the complexity of the real world, and to assume that many contributions can be made under those new approaches; however the rule "keep it simple as possible" is normally the most useful approach. The use of "Governance concept" (linked with efficiency concerns) as the main focus for analysis of a social system can be a simple approach/model to address Governance/ institutional inefficiencies, failures and respective economic entities problems such as, governments, civil society organizations, institutional framework, firms, actors/agents and any economic unit.

With the attention on looking for the best solutions to improve Governance, governability and economic efficiency, the main focus need to start at Government level, because governments are the main responsible players to establish the institutional environment under which, the other economic units work, individuals, firms, any economic entity.
It is useful to try a selection, reasonable consensual, of a set of characteristics that should be present in a reasonable good governance system at macro and governmental environment. After defining the most relevant dimensions, it is possible to start an effort to quantity achievements and constraints to the goals established and have a first approach of efficiency evaluation on "Governance."

Accordingly with ESCAP (2013) there are 8 major characteristics that should be present in any "Good Governance": Participatory; Consensus Oriented ; Accountable, Transparent, Responsive, Equitable and Inclusive; Effective and Efficient; follows the rule of law.
The graph below is illustrative, but it is not exclusive to other possible dimensions, and also not exclusive in relation to other type of organizations and/or institutions.

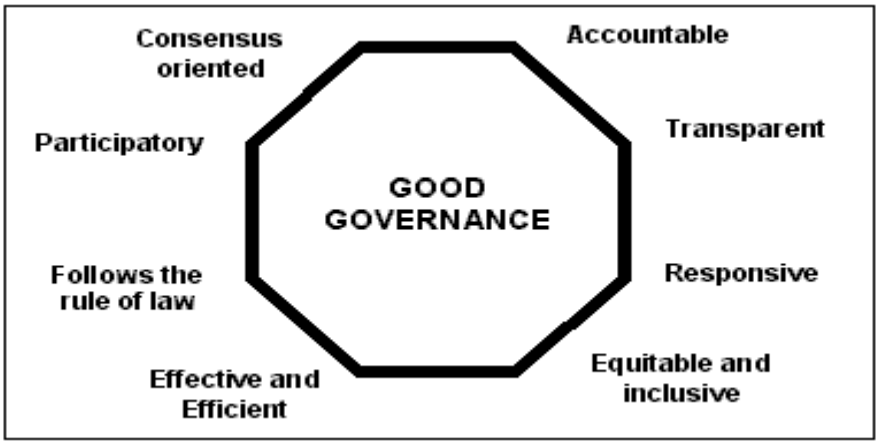

Figure 2. Set of Characteristics for Goof Governance Environment – Governmental level
(Source: ESCAP (2013) – Economic and Social Commission for Asia and Pacific - United Nations).

At Macro level, the example and effort of the World Bank, producing the Worldwide Governance Indicators, is very interesting in doing a similar exercise in pragmatic ways, classifying countries based on six dimensions, which are the following: Voice and Accountability; Political Stability/Absence of Violence, Government Effectiveness; Regulatory Quality; Rule of Law; Control of Corruption.

Those two examples are convergent in many dimensions but also show how the characteristics and dimensions considered can be different for different views and concerns. In conclusion, there is not an exclusive approach, but the purpose of measure the institutional "environment "and evaluate efficiency in the economic systems is moving on the right direction. Other examples at business level are also available, at micro and macro levels, for example in relation to several country classifications "vis a vis" the dominant "business environment." In regard to our main concern, food systems, food chain values and food security, there are also opportunities to be explored taking advantage of the examples presented.

At micro level, governance issues are also addressed and explored in the literature under "management practices" and evaluation methods, but it is possible to say that, this new approach with focus on the system dynamics and decision making + decision implementation, that is under a general concern such as "governance" of economic units, can also add a different and useful perspective.

Markets and Market Efficiency

Markets are considered, for many authors, as an institution. However, for some others, (like ourselves), markets are also a natural phenomena, present in the nature and among several species. Today is more or less consensual that markets are a necessary mechanism for allocation of resources, in production and in consumption, among people and groups of people defined as economic units. Some references from the literature will show the close relationship between markets efficiency and welfare economics.

Markets to work properly and result in an efficient choice have to respect the first and second welfare theorems. The first states, under certain assumptions concerning the convexity of individual preferences and technology, that any allocation of resources generated as a general equilibrium of a perfect competitive economy is Pareto Optimal. The second refers to the inverse situation: any Pareto Optimal allocation of resources can be achieved by the solution to a general equilibrium in a competitive economy.

"Welfare economics is the framework within which the normative significance of economic events is evaluated…Welfare economics can be viewed as an investigation of methods of obtaining a social ordering over alternative possible *states of the world*" (Broadway and Bruce, 1984, p1). It is also stated that a great part of these research area is based on the concept of economic efficiency, but some explicit stated ethical criteria is necessary. This concept is used to rank *social states* and two basic value judgments are made. The first is called "individualism" where the social ordering ought to be based on individual orderings of alternative social states, which means/assumed that each individual is the best judge of his or her own preferences. The second, very widely accepted is the Pareto Principle that states: If State A is ranked higher than State B for one person, and all the others rank A at least as high as B, then A should be ranked higher than B in the social ordering.

In summary an allocation will be Pareto Optimal overall if it is not possible to reallocate production and distribution (consumption) so as to make one person better off while making no one worse off. A set of assumptions and conditions are necessary to guarantee that first and second welfare theorems work, and when they are not present it is possible to have a market allocation not necessarily Pareto Optimal, and this means "Market Failure," in other words it is possible to have opportunities for mutual gains in the system. Note that competitive markets should satisfy at least "Pareto Optimal" conditions in production, in trade and in consumption/distribution conditions. However it is possible also to think in similar conditions for institutional arrangements and governance conditions, such that efficiency considerations can be studied also on those dimensions.

Perfect markets and perfect competition are most of the time only an abstraction, far away from reality. Traditional economic analysis, most of the time, start assuming those conditions. Within the present framework it is important to start with a most close assumption to the reality, which is, Markets do exist and are important, but most of the time work far away from perfect conditions. Research needs and science intervention is most necessary to help overcome those difficulties, in other words **it is possible to have opportunities for mutual gains.**

Food security, but mainly hunger around the world can clearly be seen as a strong candidate for a situation of Global Market Failure. Many different views and perspectives are possible, but the facts can be summarized in many situations with availability of land and labor, consumption potential available, but system failure to overcome the poverty cycle with more production and more consumption.

At this moment it is not possible to continue exploring the importance of Markets in any economy and food system, and respective efficiency considerations along with the possible ways to quantify "markets quality and efficiency." However the importance of markets in the food system is stressed, along with the limits and constraints for proper functions, but those issues deserve a specific analysis that cannot be pursued here. Today the objective is only to point out different perspectives and opportunities for more contributions from science and knowledge.

Referential Models for Development Studies in the Food Systems

Some well known models continued to be references to our actual analysis. Hayami and Ruttan (1985) tried to present a general development model, based on economic rationality and induced innovation. Nothing happens without a reason, and most of the time there is an economic rationale for observed changes in the systems. The mentioned authors explored and test the linkage between natural endowments and technology changes, trying to prove the innovation rationale. Later on Carvalho (1989) use the same framework to show the induced innovation process from the Demand Side, that is technological and technical changes occur accordingly with demand conditions. This last author end up using the same structural model to study economic changes overtime in the Food System and in general, purposing a slightly more complete model presented below.

The "ICI-Induced Changes Innovation" model was purposed (Carvalho 2004) to stress the need to look at economic regulation mechanisms, such as the Markets (based on auto-regulation capacity), but also Government decision making process and initiatives to provide the correct framework for the economic system to work properly. However this simple framework presented below end up simplifying most or our analysis in studying changes overtime. The most important and innovative idea was to consider "markets and government" at the center of the overall relations.

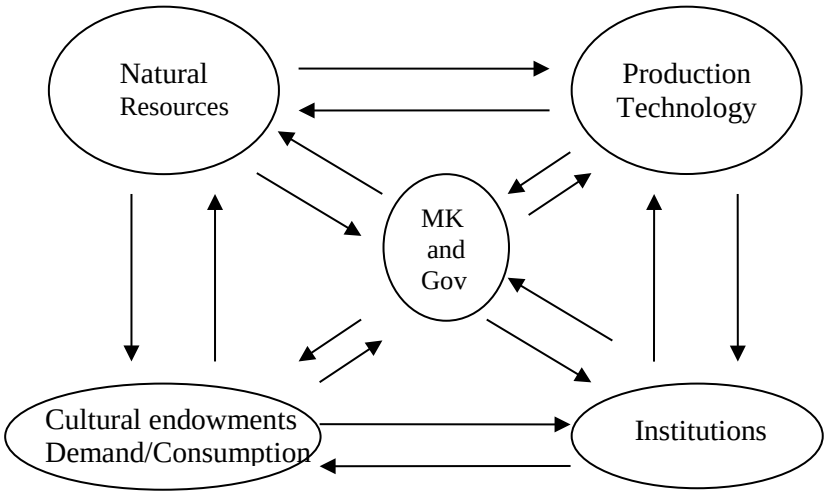

Figure 3. Induced Changes and Innovation - ICI model

Source: Carvalho, B. P. de (2004)

The model intends to be a conceptual "general equilibrium model" where changes over time can be studied and explored to understand the rationale behind it , but also the analysis of a "specific state" position can be seen and studied to look for "efficient considerations" about the reality and changes over time. Within this framework the several components discussed previously are under the same rationalization. In summary, the model has been used to test and prove the induced component of the economic change process, but now the proposition is to use the same model to check the adherence of the "actual state" with expectations and rational conditions. This methodology can offer an interesting alternative approach to study efficient conditions, not only for markets, but for institutions, governments and governance conditions.

To be more consistent in the analysis of the Food System vis a vis the "food dilemma" in today general conditions and in particular for specific country/region analysis it will be useful to consider a Structural Model, which was proposed as WFSE – World Food Security Equation (and/or Food Balance World Equation) (Carvalho et al, 2011). This model takes into consideration the "evolutionary state" of changes expected with the development process.

The approach proposed starts considering the Food Security Equation – FSE, based on the definition of Food Security, which have to consider, at least, the following dimensions;

a) Availability;
b) Access to Food;
c) Consumption components/quality/stability and social conditions, education and cultural factors, etc.
d) Risk analysis and stability of all variables considered (including risks at low/minimum level possible);
e) System vulnerability (including resilience and resistance to internal and external factors).

With this framework the Food System (and with the WFSE model – each phase) can be seen as dependent from its "state" and evolutionary position. Four different phases are considered and characterized, described as follows:

Stage/Phase I – Ecological Equilibrium

Stage/Phase II – Excess Food Demand (demand growth tends to be higher than production growth)

Stage /Phase III – Excess Supply (supply growth higher than demand growth).

Stage /Phase IV – Supply and Demand with more equilibrium, with significant growth in production only when demand constraints are "relaxed" (through export markets and other non food uses). This phase is characterized by Food Demand growth close to zero in quantitative terms ("saturation level" is reached), value creation in production still possible with innovation in terms of" Value Creation along the Food Chain."

All phases can be identified in the world today, more or less significant in certain regions, but all very much related with it its relative position in the evolutionary stage in development. However, in global terms the WFSE is now in Stage III, that is, there is and there has been in the last decades, a real surplus in food production, excess production. This situation is more or less evident after 1985. In a recent work, Carvalho et al (2011) provided a clear demonstration of this situation, information that can be used now in the next section, trying to facilitate the current analysis.

4 Facts and Data Treatment - Main Results

The information provided in relation to production growth shows the success obtained at world level and at regional level, where production has been greater than population growth everywhere at the end of the century, with only one exception, Industrialized Economies. Today the general change and tendencies identified between 1980 decade and the next decade (1990 years) is maintained in the last years already in the XXI century (data available, not presented).

Table 1. Geometric growth rate of Food Production

	1967-2001	1967-1980	1980-1990	1990-2001
WORLD	2.30	2.37	2.38	2.28
Indust. Countries	0.96	1.94	1.09	0.22
LDC´s	3.49	2.89	3.65	3.73
Latin America	2.94	3.25	2.42	3.30
Asia and Pacific	3.90	2.97	4.20	4.20
Sub Sahar. Africa.	2.33	1.59	2.74	2.78

Source: FAO/SOFA, 2002 in Carvalho (2003)

In relation to the expected behavior in Population growth, the tendencies identified in the table below, up to the end of the XX century, continues to be the trend in the actual century (XXI century), that is, a general decrease in the growth rates continues to be the expected behavior.

Table 2. Geometric growth rate of the Population

	1967-2001	1967-1980	1980-1990	1990-2001
WORLD	1.68	1.88	1.72	1.40
Indust. Countries	0.68	0.84	0.70	0.44
LDC´s	2.02	2.28	2.06	1.69
Latin America	2.03	2.42	1.98	1.62
Asia and Pac	1.82	2.16	1.84	1.45
Sub Sahar. Africa	2.83	2.74	2.95	2.66

Source: FAO/SOFA, 2002 in Carvalho (2003).

Food Availability is now better than ever before at world level, which is shown in per capita average with about 2 800 kcalories, per capita, per day. World supply has been growing around 2.3 % per year, but population growth has been declining since the 1970´s. There is a difference between rates that is growing and close to 1% at the end of the century. With those facts, the general expectations about hunger behavior around the world would be a significant decreasing rate. However this is not the reality.

Table 3. Food Supply per capita (kcal/capita/day) and total growth rate in the period

	1961	1971	1981	1991	2001	2007	1961-2007 (Geom. Growth)
World	2200	2370	2512	2620	2722	2797	0.52
USA	2881	3058	3230	3509	3683	3748	0.57
European Union	3000	3212	3279	3377	3457	3465	0.31
LDC´s	1918	1968	1957	1966	2053	2161	0.26
South America	2304	2457	2611	2637	2781	2885	0.49
Asia	1804	2026	2233	2441	2590	2668	0.85
Africa	2029	2111	2236	2298	2366	2461	0.42

Source: Faostat, 2010 data and authors calculations

Table 4. Geometric Growth rate of Food Supply per capita (kcal/capita/day)

	1961-1971	1971-1981	1981-1991	1991-2001	2001-2007
World	0.75	0.58	0.42	0.38	0.45
USA	0.60	0.55	0.83	0.49	0.29
European Union	0.65	0.21	0.30	0.23	0.04
LDC´s	0.26	0.04	-0.05	0.43	0.86
South America	0.65	0.61	0.10	0.53	0.62
Asia	1.16	0.98	0.89	0.60	0.49
Africa	0.39	0.58	0.28	0.29	0.66

Source: Faostat, 2010 data and authors calculations

The international numbers available (FAO data bases) continues to point out a serious challenge to all, mainly the ones working in food systems and food related issues. The figures below put the facts under perspective and provided the basic reference to question the rationale behind the most common strategy, which is to fight hunger with focus on production. The author started to call the attention to the demand side in 1982 (Carvalho, 1982, 1989) in regard to induced technical and technological change processes, but the study under this perspective leads also to the need to look to the innovation in institutions, new regulation needs and actions, market failure and market inefficiencies and governance needs.

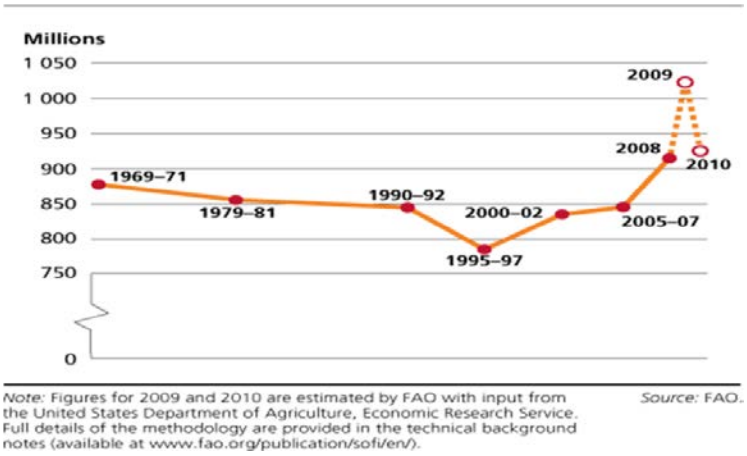

Figure 4. **Number of undernourished people in the world, 1961/71 to 2010**

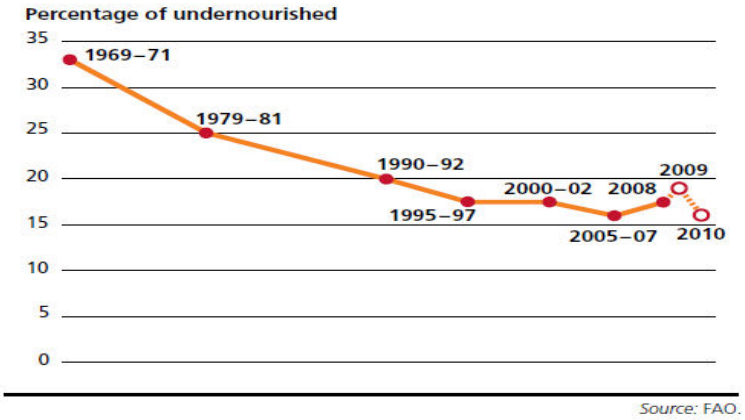

Figure 5. Proportion of undernourished people in developing countries, 1969/71 to 2010

An immediate consequence of the limited food supply growth in industrialized economies was the diminished surplus level in cereals, lower food aid and higher prices. These results seems to be a problematic issue in regard to food problems and hunger, but for the first time in many years can provide a very necessary impulse towards local food

production increase and lower “demand constraints” for agriculture growth in less developed world.

The food system is complex, and there are no linear answers to all problems involving hunger and food security issues. However, science and knowledge available can do much more in providing solutions and policy orientation.

The global Models presented can help to understand the actual complex food system in terms of providing structural expectations for the main variables in the system. On the other side, many studies in the literature have worked and tested the induced change processes. Today we proposed to use the same structure to ask question about “efficient changes” and test/identify the needs for more and quicker changes in the system. The objective now is to check for the “efficiency change process” based on the rationale and stimulus for well adapted change processes in relation to the “environment” into which the regions/countries (and economic units) work, based on the “model ICI” and expected behavior.

Indeed the data provided already can help to test the WFSE proposed. Mellor and Jonhston (1984) World Food Equation is the starting point for the actual WFSE, where the notion of “food security” is introduced and the dimensions of “Demand Constraints” are studied with great attention. This procedure gives space to point out an additional IV phase in the food system. The data in the last decade finally provided evidence of this phase, which has been mainly theoretical. Look at Europe behavior in the table 4. Almost no more growth in food supply per capita per year is occurring, which means global consumption is not growing, and will not grow in the next future in general. Carvalho et al (2011) presented and discussed this model and data in more detail.

5 Latin America/Brasil and Africa Successful Examples in Food Security

The use of real examples can help to test the models and theoretical approach proposed up to this moment, mainly when the examples provided are based on the best achievements in specific regions and when those models follows closely the rationale provided earlier in the text.

6 Brazil Example

The well known “Fome Zero” program from Brazil, which start in 2003, resulted from a political choice made by President “Lula da Silva,” which put Food Security concerns in the center of his public policy. **Governance measures** where adopted, basically (accordingly with Takagi 2010):

1) Recreation of the CONSEA – Council for Food and Nutritional Security, a global representative structure to provide support to the president, involving many associations and private sector;
2) Criation of a special Ministry – MESA – Ministério Extraordinário de Segurança Alimentar e Combate à Fome;
3) Several measures to involve the public in the process, challenge and changes needed;

4) Use of several physical and institutional infra-structure toward the presidency to help implementing specific policies and budget resources (secretaria da comunidade solidária, adding in the budget R$1,8 bilions, for specific actions)

Initial Main Policies 2003:

a) Family assistance (finance support through a food card – Programa Cartão alimentação – with R$ 1,2 bilions)
b) Purchasing Food from Family Farms (PF-FF), known as PAA – Programa de aquisição de alimentos da agricultura familiar – with R$ 400 millions;
c) Actions related to food education (with R$ 200 millions)

All these programs and actions where pursued in several ways and public policies that can be characterized in structural, specific and local policies (Aranha 2010). All these policies were defined under a global Program – Programa Nacional de Segurança Alimentar e Nutricional (PNSAN). In 2004, the Program was absorbed by a new Ministry – Ministério do Desenvolvimento Social e Combate à Fome (MDS), trying to incorporate this policy into a normal routine and with similar "Status" like others national policies such and health policy, social assistance, education, etc. The basic principle was to establish Food and Nutritional Needs as a basic human and social right.

Note that was assumed clearly, that the hunger problem in Brazil was not lack of food or lack of production and product availability. The identified problem was lack of access and social needs (Aranha 2010). FAO data (cited by the same author) shows that Brazil had 2216 kcal/per capita/day in 1961 and in 2003-2005 was already with 3094 kcal/per capita/day. Note also how similar those numbers are with the global situation today at world level, 2200 kcla/per capita/day in 1961 and 2797 kcal/per capita/day in 2007 (table3).

It is not the time to go into detail on many different initiatives promoted after 2003 up to now, but in general the key aspects pointed above are the main references for a huge set of policies, which were and still are mainly governance related (better governance) and aiming to relax "demand constraints." It is important to note that since the beginning the Program" Fome Zero" was undertaken based on structural measures also at macro level, such as promotion of employment, income distribution, minimum income and social assistance, land reform and family agriculture.

To have a quick overview about the results, a selection of some data obtained is presented. In general poverty reduction was very significant with more than 20 million people changing their status (leaving poverty level) within a 6 year period, between 2003 and 2009 (Del Grossi 2010). The same author mention the continuous effort and challenge still needed with the remaining 29,5 million people still in poverty, but the relative impact was tremendous with a reduction close to 40% in a very short period. But the reduction intensity was greater in rural areas, with an estimation of 5 million people leaving poverty level.

To have a closer look into rural areas, the dynamics of rural areas were considered with a classification of the people leaving in those areas and the ones leaving in urban areas

engaged in agricultural activities. Following this perspective (Del Grossi 2010) economically active families, agricultural families, were classified in the following way:

A. Family farming: comprises families engaged in an agricultural "enterprise"/business activity, whether they own or not land, living in urban or rural area. In accordance with the "Pronaf program" (financing agency for family farming, this classification comprises the production units up to 2 hired permanent employees);
B. Industrial farming: families with access to an agricultural enterprise/business with three or more permanent employees living in an urban or rural area.
C. Non- agricultural rural families: families of employers or self-employed people whose members are engaged in non-agricultural activities, although they live in rural areas;
D. Rural wage earning families: families living from their wages in a rural area (including both the ones living in urban areas but working in rural areas, and the ones living in rural areas and working outside).

Table 5. Number of Agricultural families according to their poverty status in Brazil (family numbers in thousands).

Family type	2003	2009	Difference
A	**7709**	**3570**	**-4139**
B	**0**	**0**	**0**
C	**998**	**575**	**-423**
D	**7855**	**4662**	**-3193**

The numbers are quite impressive and related only with the rural world, where poverty is more problematic. Most of the poverty in the world is rural. Takagi and Graziano da Silva (2010) states that 75% of world poverty is rural, however in Latin America is lower, about 40%. Note that in 2007, 52% of people leaving in rural areas are under poverty in Latin America, but in the period 2003 to 2007 the agricultural production growth was in average 4,8% per year (Takagi and Graziano da Silva 2010). Again, the evidence shows that production growth is very important but not sufficient.

In general Takagi and Graziano da Silva (2010) notes, for Latin America, that the "development agenda" in the last times (last decades) has been based on macroeconomic adjustments in the pass and not in sectorial policies, based on open economies to promote industrialization and not industrialization of the agricultural sector, poverty reduction through income transfers and not through autonomous income raising activities, and lower investment in agricultural sector, discouraging investments in agriculture due to low international prices. The example of Brazil provided a different perspective, and specifically the" Fome Zero Program" offers a lot of innovations to be taken into consideration

The same author offers a sound analysis of the "Fome Zero Program," pointing out some key aspects to be taken into consideration for international policies. Among them, accordingly also with the present analysis, it is possible to say:

1 – Concepts and "models" are important to address the hunger dilemma. "Programs against hunger should be based on the concept of food security and of the right to food;

and they should be comprehensive, addressing elements related to production and access to food."
2 – With sufficient political will it is possible to secure a rapid and significant reduction in poverty and hunger levels.
3 – The programs can be financially feasible to reduce hunger in the short run. The "Bolsa Familia Program" benefits 12 million families, around one- fourth of Brazil population (about 200 millions), "but it only requires investments of a little over 2% of the federal budget and of only 0,4% of the GDP".

Many other elements can be derived from the Brazil experience, but it is also interesting to look at other examples that can be viewed under the same "structural umbrella" and models presented before.

It is important to start with an almost opposite situation, in regard to natural resources endowments, human resources, level of development and dimension. The chosen country is Cape Verde, because of the cultural background, but basically because the author experience and knowledge about the reality and about public policy implemented. Our research center (Centro de Agronomia Tropical – Cooperação e Desenvolvimento, CIAT-CD – Center for Tropical Agricultural research and development) has been directly involved with the process and with the definition of food policies in this country in the last decade. The country is a small archipelago in the middle of the Atlantic with about 500 thousand people, about 40 000 ha of reasonable land for agriculture and very dry climate, with an average of about 200 mm of rain per year, with a very bad distribution in the year and geographically among the 9 islands. The country is very dependent from food imports, but local production is also very important.

The policy intervention is this country was centered in Market efficiency problems and access to food, with Institutional innovations. An important innovation was the creation of a Food Security Agency in 2002, ANSA – Agencia Nacional de Segurança Alimentar, with the objective of supporting basic food markets and food aid administration. The original objective was to substitute a public enterprise with about 1.5 thousand people working in distribution of basic food stuff, EMPA – Empresa Pública de Abastecimento) with at least the same guarantees in regard to food security status of the country and families around the 9 islands. This process was achieved with great success, namely in regard to price variations, product availability and food access.

A second example in Africa is also interesting to follow, now with a very small country, on the Equator, tropical humid climate, good natural resources endowments, but very poor and isolated. The country chosen is São Tomé e Principe, and this choice is also based on the knowledge and personal involvement, again through the CIAT-CD. The strategy followed in this last one case has been based on markets functions but also on the natural resources opportunities, improving information and education. Carvalho (1998) worked looking at consumption efficiency alternatives, looking at local products capability to compete with imports.

More recently Severino (2012) and others have explored alternative local products, mainly rich protein food sources, that can enter into the local diet with clear benefits, at

least in regard to local availability and prices. Again the importance of information/knowledge and education are keys aspects to be taken into consideration to promote changes.

The country has been under a strong structural reform in the last two decades, where access to land was very much promoted for family production, with some success in today reality, however with dangerous risk/ impact in terms of sustainability. Overall the results in food security terms have been very positive in the last years.

The two examples given for Africa continent are certainly examples of the best practices and achievements in regard to food policy and food security changes in the right direction (see table 6). This is not to say that the food challenge is not there and hunger eradication already obtained as a final result. Much more needs to be done to achieved the possible food security conditions for the people along with better quality of life.

Table 6. Food Consumption average in kcal/per capita/per day in different regions and countries, respective evolution between 2000 and 2007.

	Years		Differences
Region	2000	2007	kcal/capita
World	2725	2796	71
Low Inc.	2508	2569	61
Small Island Developing	2483	2558	75
Africa	2347	2455	108
Cabo Verde	2370	2572	202
São Tomé e Principe	2373	2684	311
South America	2782	2886	104
Brazil	2885	3113	228

Source: FAO – Food Balance Sheet, June 2012.

Note that Cape Verde and São Tomé e Principe (STP) changes in food availability are improving at the same rate or even faster than in Brazil (the case of STP), comparing with their own regions in relative better positions. Data supports the good behavior achieved in those two countries in Africa, but one of the most interesting results is to realize that "capital" investment necessary to those results was very limited. Science, knowledge and political will are certainly key factors present in those results, along with reasonable governance in the food system.

7 Conclusions

The research and results presented provided a sound basic structure to review the recent approaches aiming to provide policy orientation in defining food policies able to have a strong impact in the actual situation "on hunger" around the world. Some principles and

traditional views to deal with food and hunger problems were questioned and some new referential ideas presented. The need to have a systemic view, using the food security concept was discussed and somehow confirmed. The usefulness of the methods proposed for food systems analyze proved appropriate when integrating the view of a structural change process with development, using the proposed World Food Security Equation - WFSE model with the Induced Innovation model (ICI-model).

The identified hypotheses were tested based on data and bibliography references available. The evidence showed how important has been production growth, but clearly a necessary condition in the long run but not sufficient to solve the hunger dilemma around the world. Demand side approach showed to be determinant, along with all the variables determining food access problems and possible solutions. Failures in several dimensions were stressed, and introduced an important less frequent issue based on the idea of exploring efficiency and inefficiencies conditions in production, in consumption, markets and last, but not the least, governance conditions. The theoretical revision and models proposed brought a different view in trying to explore the study of efficiency and inefficient conditions. The basic induced innovation model, which has been called the ICI model – induced change model, has served to provide the rationale to look for changes and how those changes occur, but basically aiming to prove the **induced and economic rationale** behind the observed changes. The proposed approach, after many years of empirical work to test the model, suggests using the referred model to test how efficient the systems are in promoting changes and how rationale those changes can be. That is to say, that it is possible to look for efficiency considerations in the food dynamics change process, exploring alternative interventions using the actual knowledge available and the cumulative experience obtained (and the referential models proposed).

The last part, the empirical observation and data presented based on countries experience, was very important in regard to explore the linkages between the results obtained and the models and policy orientation prescribed through the provided analysis. It seems very interesting to be able to conclude that the knowledge available and cumulative experiences with the new approach have been able to show results far better than ever before. Latin America reference, with Brazil leadership behavior in food security improvement and poverty alleviation has been recognized worldwide. Also important, but less known examples are the African examples presented, which also showed alternative strategies to be pursued in specific conditions, but the most important result was to show how those economic actions and policies can be consistent will the new approach proposed.

The contribution in this research is clearly a starting point for discussions and further work, but showed a tremendous potential to make a huge difference in a very short period of time if the knowledge available and scientific efforts can be focused and correctly appropriated by our political and policy leaders. Hunger around the world cannot be seen only as one more problem of our society. It is a question of basic citizenship and civilization. The Food related scientists need to improve their “governance” capability to promote the necessary changes, mainly when they have instruments and technical expertise to do it.

Bibliography

Aranha, A.V.(2010). Zero Hunger: A Project Turned Into a Government Strategy. In The Fome Zero Program. The Brazilian Experience. Graziano da Silva, J. , M.E. del Grossi and C.G. de França edit.FAO and Ministry of Agrarian Development. Brasilia. Brasil.

Belik, W. (2010). Mobilization of Enterprises Around the Fight Against Hunger. In The Fome Zero Program. The Brazilian Experience. Graziano da Silva, J. , M.E. del Grossi and C.G. de França edit.FAO and Ministry of Agrarian Development. Brasilia. Brasil.

Boadway, R. W. and N.Bruce (1984). Welfare Economics. Basil Blackwell Inc. Oxford, England and Ney York, USA.

Carvalho, B. P. de, Costa, D. and Leite, I (2011). Global Food Outlook: Global Challenges and Local Solutions. IFAMA, 21 st Annual World Forum and Symposim Frankfurt, Germany.

Carvalho, B. P. de, Monteiro, D. and N. Carvalho (2009). Global Challenges and Local Solutions: Wine Sector Changes in Europe and in Portugal. IAMA, 19 th Annual World Forum and Symposim Budapeste, Hungary.

Carvalho, B. P. de (2005). Segurança Alimentar, Qualidade de Vida e Desenvolvimento. Revista de Ciências Agrárias, XXVIII (1), 148-158pp. Sociedade de Ciências Agrárias de Portugal. Lisboa.

Carvalho, B. P de (2004). Cooperação e Desenvolvimento: Oportunidades e Desafios para o Sec. XXI. (Cooperation and Development: Opportunities and Challenges for the XXI century). SEDGES 10(3). Série de Estudos de Desenvolvimento e Gestão de Sistemas. CIAT – CD/ISA/UTL. Center for Tropical Ag. Research – Cooperation and Development. Instituto Superior de Agronomia – Universidade Técnica de Lisboa.

Carvalho, B. P de (2000). Regulatory Development in Food Security: Republica de Cabo Verde. World Bank supported study for the Prime Minister Office. Cabo Verde.

Carvalho, B. P de (1998). Food Security and Hedonic Behavior: a case study of São Tomé e Principe. *Food Policy,* Vol. 23, nº3/4, pp263-275. Elsevier Science Ltd. Great Britain.

Carvalho, B. P. de (1989). Demand Constraints and Technical Change. PhD Thesis. University of Minnesota. St. Paul/Minneapolis. U.S.A.

Carvalho, Bernardo P. de (1985). Dualismo e Desenvolvimento na Agricultura. *Revista de Economia Rural* 23(1): 41-54, Brasília.Brazil.

Carvalho, B. P. de (1982). Modernização da Agricultura: Analise de 6 Culturas no Brasil. Master Thesis. ESALQ- University of S. Paulo. Brazil.

Comission on Human Security (2003). Human Security Now. Report to the United Nations from an independent comission launched at the 2000 UN Millenium Summit, an initiative from Japan Government. New York.

Del Grossi, M.E.(2010). Poverty Reduction. From 44 Million to 29,6 Million People.

In The Fome Zero Program. The Brazilian Experience. Graziano da Silva, J. , M.E. del Grossi and C.G. de França edit.FAO and Ministry of Agrarian Development. Brasilia. Brasil.

ESCAP (2013). Economic and Social Commission for Asia and Pacific. United Nations.

Access in http://www.unescap.org/pdd/prs/ProjectActivities/Ongoing/gg/governance.asp (2013.02.04)

FAO, Food and Agriculture Organization of the United Nations, 2009 to 2012.

FAOSTAT 2012 and 2013. On line data bases.

FAO (2009-12). The State of Food and Agriculture. Rome.

FAO (2010-12). The State of Food Insecurity in the World. Rome.

Espirito Santo, Severino and B. P. de Carvalho (2012). Food Consumption, Food Chains and Market Evolution in São Tomé e Principe. 6 th International European Forum (Igls Forum). Austria. Organization of the International Center for Food Chain and Network Research. University of Bonn.

Hayami, Y. e V. Ruttan (1985). Agricultural Development: an International Perspective. The John Hopkins University Press. Baltimore and London.

Mellor, J. W. and B. F. Johnston. (1984). The World food Equation: Interrelationships among Development, Employment and Food Consumption," *Journal of Economic Literature, vol.22*, pp.531-74.

Lee, J.D., Seogwon, H. and T.Kim (2005). The Measurement of Consumption Efficiency. Considering the Discrete Choice of Consumers. Journal of Productivity Analysis, 23,

pp 65-83. Springer Science+Business Media, Inc. The Netherlands.

Omta,S.W.F. and S. J. Hoenen (2012). Three Fundamental Perspectives on Supply Chain Management. In Food Value Chain Network in the 21st Century: International Challenges and Opportunities. Julian Briz and Isabel de Felipe org. Editorial Agrícola Espanhola, S.A. Madrid.

Peterson, W. (1986). Principles of Economics. Micro. Six Edition IRWIN, Homewood, Illnois.USA.

Puntansen, A. (2013). Consumption Efficiency: A Missing Concept in Mainstream Economics. Director of the Rural and Social Management Institute. Thailand Rural Reconstruction Movement Foudation under royal Patronage. Thailand.

Access in http://budhist-economics info (2013,02.03).

Silva, P.R. (1977). Eficiência Técnica vs Eficiência Económica. Revista de Ciências Agron. 7 (1-2): 157-163. Fortaleza-Ceára.Brazil.

Takagi, M. (2010).Implementation of the Zero Hunger Program. In The Fome Zero Program. The Brazilian Experience. Graziano da Silva, J. , M.E. del Grossi and C.G. de França edit.FAO and Ministry of Agrarian Development. Brasilia. Brasil.

Takagi, M. and J. G. da Silva (2010). New and Old Challenges to Achieve Food Security in the 21 st Century. In The Fome Zero Program. The Brazilian Experience. Graziano da Silva, J. , M.E. del Grossi and C.G. de França edit.FAO and Ministry of Agrarian Development. Brasilia. Brasil.

Williamson, O.E. (2000). The New Institutional Economics: Taking Stock, Looking Ahead. Journal of Economic Literature, Vol 38, N.3, pp 595-613.

World Bank data bases. Worldwide Governance Indicators. Access in http://info.worldbank.org/governance/wgi/sc_chart.asp. (2013.02.05).