

# THE CONDITIONS OF SUSTAINABLE FOOD SECURITY: AN INTEGRATED CONCEPTUAL FRAMEWORK

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## Editorial Note

Of all the determinants of health, food security is the most basic. Without adequate and nourishing food, health cannot be sustained. This article develops a research methodology to assess food security at six different levels of complexity, showing how and why they interrelate.

## FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

[. . .] the metaphor “food window” [is] a means of gaining insight into a society based on the values, behaviors and expectations associated with the production, distribution, and consumption of food. Addressing the social factors surrounding food security . . . serves as a window through which we observe the complexities and challenges emerging from the competing structures of production and consumption. (Corbett 1991: 251) [Corbett attributes this metaphor to Joseph Collins (1985: xvi) in *Nicaragua: What Difference Could a Revolution Make?* Rev. ed. San Francisco: Institute for Food and Development Policy.]

### FOOD SECURITY

In 1975, the United Nations’ World Food Conference equated food security with a situation where adequate supplies are available to meet the growth in world consumption. Food security is:

Availability at all times of adequate world supplies of basic food stuffs . . . to sustain a steady expression of food consumption . . . and to offset fluctuations in production and price. (United Nations 1975, quoted in Le Normand 1996: 89)

In 1983, the Food and Agriculture Organization indicated that access to stocks is as essential condition of food security as the existence of stocks:

Food security is ensuring that all people at all times have both physical and economic access to the food they need. (Food and Agriculture Organization (FAO) 1983, quoted in Le Normand 1996: 89)

The analysis of food security must now include accessibility, consumption, production, and circulation, or availability, of stocks. Accessibility and individual consumption are linked to a new set of factors, not reflected in the global economic analysis. Indeed, they are linked to the dynamics of the relations between institutions and within institutions where the circulation of food takes place. This circulation takes place at several levels and is determined by a complex set of factors.

- between world markets and nations,
- between national stocks and regions,
- between regional stocks and communities or families,
- between family stocks and the final individual consumption.

Commercial transactions are among these factors, as well as non-commercial transactions. Within households, non-commercial transactions may determine individual access to food and where factors such as food preferences, the sexual division of roles, and nutritional needs come into play.

In 1996, the World Food Summit proposed a new definition, which we will adopt here”

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (WFS 1996a)

It presupposes that numerous conditions (much more numerous than those set out by the United Nations in 1975) must be met to achieve a state of food security.

To eliminate nutritional problems, it is not enough to increase global food availability. Of course, adequate quantities of healthy and nutritional food must be available to meet the needs of a population, but above all households must have adequate access to existing supplies. Foodstuffs must then be prepared adequately and distributed fairly among all members of the family. Finally, to benefit fully from the foodstuffs consumed, the persons must be in good health and capable of absorbing and efficiently metabolizing the nutrients; they must have clean water, basic sanitation and clean air; they must have access to satisfactory health care services and must lead an active and healthy life. (Benbouzid et al. 1995)

Here, food security is a basic human right. At an individual level, it is the assurance of an active, healthy life leading to the availability of functional human resources; at the world level, it is the assurance of a climate of social stability leading to the expansion of world economic markets (World Bank 1986 quoted in Le Normand 1996: 89 ; Johnston 1997, European Community 1995).

### CONVERGING STANDARDS

There is no definition of the sustainable development concept that is both the subject of a consensus and in use. In fact, it can be understood either as a synonym of “economic growth that is compatible with future needs,” justifying globalization; or as the antonym of growth, as it necessarily leads to the destruction of the environment (Duhaime 1998). There is a third definition of sustainable development, which we are adopting here: “development without growth beyond the environment’s capacity” (Goodland 1994).

The Food and Agriculture Organization’s definition of food security and Goodland’s definition of sustainable development are the two central concepts on which our work is based. They indicate objectives regarding human development in general that can be adapted to the circumstances that are peculiar to each social group. The use of concepts as the basis of scientific work can

take away from the objectivity of the actual scientific work. However, scientific research is based on strict rules: the explanation of the prior notions, the clear statement of each founding concept, the use of defined concepts for the interpretation of results, including for the interpretation of results that seem to contradict the working hypotheses. A prerequisite for the objectivity of the scientific method is that the biases created by the use of concepts must be revealed.

Our position can be summarized in the following proposals.

1. We recognize that food security and sustainable development are socially desirable. They lead to targeted research.
2. We recognize that, within a concept, we must clearly state our understanding of it.
3. Once our understanding of the concepts is made clear, we will follow all of the following research stages in keeping with the rules of the scientific method.

It is important to point out that we are beginning the construction of a conceptual model in this paper as the initial phase of large-scale research on food security in Arctic regions.

Food security and sustainable development have several characteristics in common.

- The two can be the basis for evaluative research, in which an existing state is compared to a desired state.
- They can lead to the identification of necessary changes in behaviours and mentalities.
- They direct concerns towards the durability of a proposed action. In the case of food security, the availability and accessibility of food resources must be maintained to correspond to the needs of human consumption. In the case of sustainable development, the development must be possible indefinitely.
- A process fosters food security and sustainable development if it helps to increase fairness and social justice, local participation, if it reduces social conflicts and so on.

This does not mean that the two concepts are identical. Some examples could show that they are sometimes contradictory. It does suggest that there is a strong convergence between them.

This convergence can be maximized by including “food security” and “sustainable development” under the “sustainable food security” formula (Asenso-Okyere et al. 1997, Chambers 1988 quoted in D. Maxwell 1996, Food and Agriculture Organization 1998b, Speth 1993 quoted in Gürkan 1995).

This does not negate the specific characteristics of each concept. Instead, we suggest that any condition considered in the evaluation of food security must be compatible with our conception of sustainable development; conversely, any condition considered in the evaluation of sustainable development must be compatible with our conception of food security.

### AN INTEGRATION MODEL

Our objective is to propose a conceptual framework or model that integrates the components at work in the food system, assumes multiple interrelations, and allows us to analyze the state of food security (or insecurity). The model that we propose is based on three basic rules.

- First, the model must be based on a broad vision of the problem, in order to be able to integrate all of the dimensions, all of the components. The aim here is not to create a causal model, but rather a relational model that incorporates all of the factors that contribute, directly or indirectly, to defining the state of food security in a given geographical area.
- Second, the model must be useful in all situations, not only in malnutrition or food insecurity situations. The components of the models must describe pertinent realities and permit the integration of all possible values.
- Third, the model must be functional. We want to provide sufficient indications at the theoretical level that the model can be made functional later and then be implemented. Ultimately, the model should make it possible to identify the conditions on which we can act to increase food security in a sustainable perspective.

Apart from a few well-known exceptions, that of Milton Freeman for example, there has been little study of food security in the circumpolar Arctic. The food problems of the Arctic never have been of the scope of the Saharan famines, for example. Still, food security issues in the Arctic zones share common elements with zones that have been studied more often:

- preexisting indigenous societies,
- colonial history motivated by the presence of natural resources,
- penetration of western culture,
- disappearance of self-sufficiency,

If the model adequately takes into account all of the relevant conditions, it will allow us to consider variations of these conditions. Our project involves creating a general model that can apply at all latitudes.

Finally, it involves a conceptual framework. This framework is not a food security or food system theory. At its current development stage, the proposed framework forms a systematic guide for the examination of food security regardless of the context. It involves a broad vision, initially inspired by the economic sociology field, where economic phenomena are understood in their relations with all of the forces in play.

## A MULTI-DIMENSIONAL MODEL OF SUSTAINABLE FOOD SECURITY

### OVERVIEW

The proposed model is composed of three elements (Figure 1).

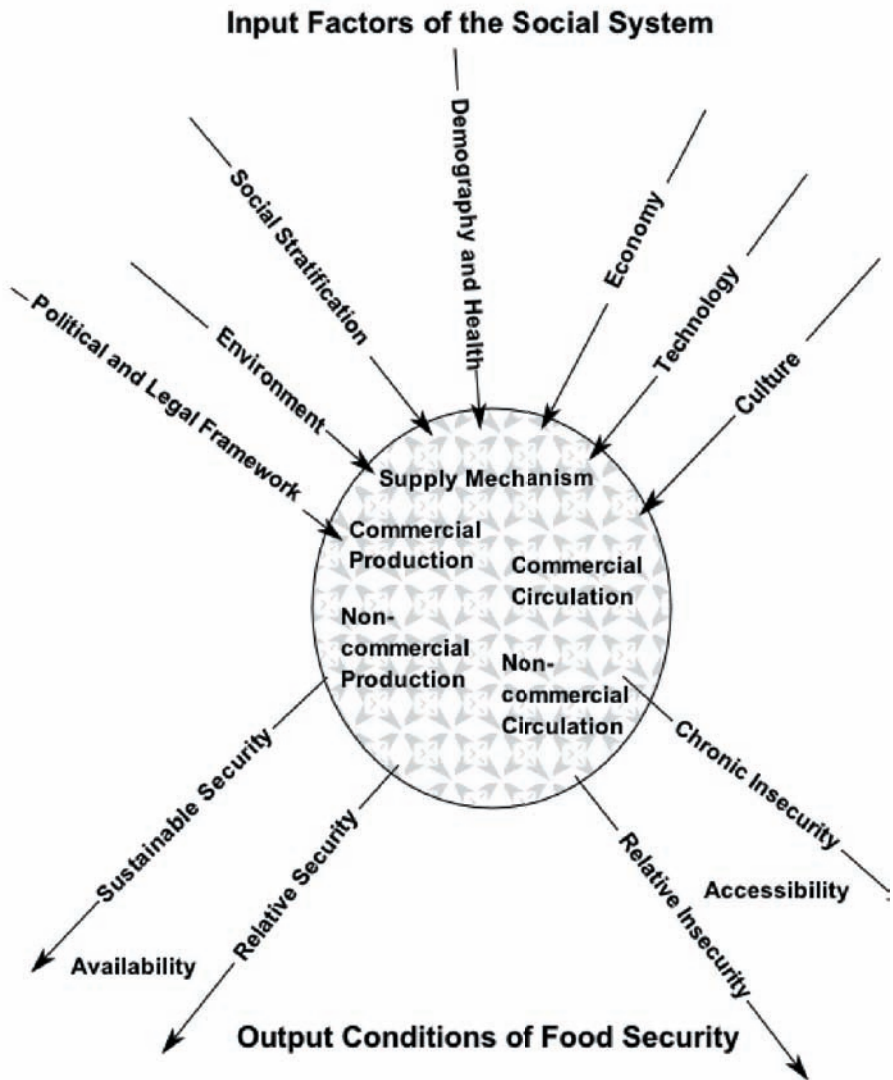
1. Input, the element that provides the system with the raw material to be processed. It is a constantly changing flow of information, resources, energy that influences the other elements of the core. In this model, the input is composed of factors of the social system.
2. Intermediary or interaction mechanisms, which select the information and resource flows, interact with them, and transmit the modified flows to the output. In this model, intermediary mechanisms are composed of food supply production and circulation mechanisms.
3. Output, the element that processes the system material to produce a result. In this model, the output is composed of the conditions of food security.

Multidirectional ties link the three elements. They indicate that the elements interact with one another according to all possible theoretical combinations. The output may exert a return influence on the input directly and, through the intermediary mechanisms, indirectly. The intermediary mechanisms may exert an influence on the input, and the input may exert an influence on the output without the intermediary mechanisms. The entire core and these three basic elements are influenced by the global environment in which they evolve, forming an open system.

### NATURAL ENVIRONMENT

The food security model must recognize that human activity takes place in a given environment, the biosphere, and that this essential condition can have major effects. Planetary climate changes, whether or not caused by human activities, can have a decisive influence on human activity, and can modify the course, the means, or even the ultimate ends of such activity.

Figure 1. Food System



All of the components, the interrelations and the levels are situated in the natural environment underlying the model. To facilitate the reading of the graphical representation of the food system, we indicated the ties between the basic elements of the core at each level of analysis. The dotted lines in the circle give some indication of possible influences between the components.

## THE FACTORS OF THE SOCIAL SYSTEM OR INPUTS (INP)

The factors of the social system are gathered together in seven main groups: environment, demography and health, technology, the economy, social stratification, politics and legal framework, and culture (Figure 1).

### THE ENVIRONMENT (ENV)

As a factor of the social system, the ENVironment consists of the natural conditions likely to act on human activities. It influences the other factors of the social system, as well as the other components of the food system. It may have beneficial effects on food security, but it may also have negative effects.

The main characteristics of the ENVironment which influence the production, circulation, availability and access to food resources are:

- the abundance and diversity of resources
- favorable climate conditions
- soil composition and fertility
- clean air and water

The presence of these characteristics has a positive influence on food security. The absence of these characteristics (Food and Agriculture Organization, 1996a) has a negative influence on food security.

Food security is harder to ensure in zones that

- lack resources,
- are in extreme, marginal (Courade and Peltre-Wurtz 1991: 3), or abnormal (Froment and Koppert 1991) climates,
- are located where lands, rain, erosion, cold and obscurity reduce the fertility of soils or
- are difficult to access (Kermel-Torres and Roca 1991)
- have an unfavorable health environment (Le Normand 1996: 88).

The circumpolar Arctic provides examples of ENVironmental factors which can alter food security.

- the contamination of the food chain by sudden disasters or by pollution carried over large distances
- global warming, which is thought to affect fish stocks and the migration of large land mammals.

### DEMOGRAPHY AND HEALTH (DEM)

Population structure, or DEMography, encompasses the following areas.

- distribution of population by age,



- distribution of population by sex,
- growth and decline of populations.

The size of a population is influenced by

- fertility or how many babies are born,
- mortality or how many people die,
- migration or how many people enter or leave.

Each of these is a major determining factor in food security. Together, they determine food production (or the production of income to meet food needs) and the amount of food required. A growth in the population may result in food supply shortages (European Community 1995, Minvielle 1991: 183). A decline in population may result in manpower shortages (Chastanet 1991: 141). Food insecurity strikes large households more (Odounfa and Akindès 1991: 233, Haddad and Kennedy 1994: 334), and people who are alone and without a social network (Blaylock and Blisard 1995: 961, Rouffignat 1997).'

A population in good health has a positive influence on the other factors of the social system and the other components of the food system, which promotes food security. A healthy population provides a productive labour force participating in the economy and using the necessary resources to meet their needs. A population in poor health has a negative influence on the other factors, resulting in a non-productive population whose needs cannot be met in a self-sufficient manner (Gaburici 1995).

Rapid DEMographic growth imposes major food constraints. In the Arctic, rapid DEMographic growth has had the following results.

- transformation of living conditions to permanent homes
- increased access to health services
- outfitters need more money for and food production equipment
- more people work for money to pay someone else to produce food
- larger crop yields are needed
- game and fish are more heavily hunted, which is detrimental to vulnerable species
- imported products and food styles instead of the traditional diet from hunting and fishing
- imbalanced diet leading to obesity, diabetes, illnesses of the circulatory system (Delisle et al. 1994)
- diversion of resources to health care

Finally, the use of local resources is affected by environmental phenomena. Pollution travelling by air and sea currents penetrates the food chain and is concentrated in certain edible and coveted parts of game (for example, PCBs in seal and beluga fat, cadmium in caribou liver, mercury in freshwater fish meat). This limits the use of game for food purposes, in particular for groups having higher risk factors such as mothers giving birth and the elderly, and calls into question pre-existing food balances.

### TECHNOLOGY (TEC)

TECHnology encompasses all of the methods which increase human mastery of the environment. These include production, transportation and communications means and infrastructures.

The use of TECHnology is generally presented as improving food security (European Community 1995: 4; Gaburici 1995 ; Gürkan 1996, Kracht 1995, Salazar de Buckle et al. 1989, SMA 1996: 9; Blandford and Viatte 1997: 7). Its most sensitive effects are

- to promote the functioning of supply mechanisms,
- to maintain the stability of the food supply, and
- to prevent changes in food supply levels.

TECHnology permits the development of the supply production and circulation processes. The effects of these developments are

- to increase productivity,
- to reduce losses,
- to reduce price fluctuations and
- to promote and diversify exchanges including importing and exporting (European Community 1995: 3, Giroux 1995: 10).

The emphasis on TECHnology also has some drawbacks.

- A population may not have access to TECHnology because it is expensive.
- The adoption of TECHnology requires considerable resources, which would otherwise be used for the primary needs of the population, including food needs (Giroux 1995, Le Plaideur 1991, Kachondham 1998, Chossudovsky 1998).
- TECHnology replaces traditional practices even where the traditional practices are more efficient for meeting the population's food needs (Lehman 1966: 1).
- TECHnology can lead to a poorer diet by promoting, for instance, the

distribution of products with a low nutritional value (Corbett 1991: 245, Kachondham 1995: 5).

- TEChnology can lead to food insecurity by contributing to the deterioration of the environment and a non-sustainable harvesting of resources (Food and Agriculture Organization 1992 quoted in Benbouzid et al. 1995: 48, Dyson 1994, Gaburici 1995).

In the Arctic, TEChnology in the form of air and sea transport has had the following effects.

- villages are no longer isolated from large cities,
- stable supply networks from cities to villages have been established
- imported goods are easily brought in (see Lawn and Langner 1994).
- The use of firearms and snowmobiles has increased the productivity of hunting for food.
- Radio, television, travel, and contact with people passing through have changed people's images of the world and their place in it.
- residents of the North must have earnings to maintain a consumption based on imports,
- fuel and spare parts for snowmobiles, ammunition for firearms, camping equipment must all be purchased.
- imported TEChnologies have contributed to the disappearance of the remnants of self-sufficiency;
- numerous interdependence ties have been established and more are developing (Duhaime 1990, Kruse 1991, Myers 1982, Simard et al. 1996).

### ECONOMY (ECO)

The ECONomic organization of society has an influence on the other factors of the social system, as well as on the other components of the food system. Globally, an economic organization which provides fair access to productive resources, the land, capital, and work, as well as the distribution of wealth, contributes to food security. In contrast, an organization based on inequity reduces the food security of the population.

ECONomic factors can have many effects on food security.

- Access to money at the individual, family, local, regional or national level permits a better use of human resources, the land and production means (European Community 1995, Kermel-Torres and Roca 1991: 48, Phélinas 1991: 69).

- The resulting development of farm, commercial, communication and transport infrastructures, the private sector and work for wages stabilizes the food supply.
- Trade increases and a fair market-oriented commercial system develops.
- a market Economy may force local producers to abandon food production, which guaranteed the supply of local products and created jobs, for work for wages (Lehman 1996: 1, Whiteford and Ferguson 1991).
- a global market economy may, on the local level, leave a large number of the undernourished unable to produce food or buy it.
- Political unrest, faulty Economic organization, or unfavorable Environment can all create inadequate access to the means of production (land, water, seeds, income, credit, Technology), due to political unrest or a faulty economic organization, when it is not due to unfavorable environmental conditions, etc.
- underground Economic organizations may developed, including smuggling of foodstuffs (Phélinas 1991: 68, Giroux 1995: 7, Kermel-Torres and Roca 1991: 47) and stealing resources (Droy 1991: 117-127).

In the Arctic, the Economic organization has undergone rapid and major changes. Before there were sustained contacts with the colonizers of the New World, self-sufficiency prevailed. Fur trading modified the harvesting of resources according to the requirements of fur-traders. The income from the fur trade added market consumption to home consumption.

The loss of the fur trade as a factor in the Aboriginal Economy (Grygier 1994, Duhaime 1985) resulted in a series of epidemics and famines. The government's answer was to construct permanent villages that changed the foundations of the Arctic Economy. Wage-earning became the dominant form of Economic production instead of hunting and fishing for food purposes. Wages were made possible by the large-scale development of natural resources, such as oil, mineral resources and hydraulic energy, as well as the development of the public administration as an industry.

### SOCIAL STRATIFICATION (STR)

Social STRatification, or one's place in society, contributes to defining the food situation of a person, a household or a region. Sufficient income leads to food security; poverty leads to food insecurity (European Community 1995, Salazar de Buckle et al. 1989). Poverty is defined as the absence of or the lack

of access to resources and the ability to use them. Poverty limits the ability to react and adapt to food insecurity. This primarily affects

- women (70% of the poor are women, according to the World Food Summit 1996),
- children,
- rural populations,
- Aboriginal populations,
- unemployed urban populations,
- minorities,
- nomads,
- victims of wars and other disasters of a natural or human nature (Denis 1996: 99, Rouffignat 1997, World Bank 1996: 2-3).'

In several regions of the world, those with money — the upper STRata — are able to maintain or improve their position, to the detriment of those without money — the lower STRata. The control exercised by the upper STRata over the lower STRata reduces the ability of the lower STRata to improve their living and food conditions.

#### POLITICS AND LEGAL FRAMEWORK (POL)

POLitical power has a profound influence on activities in a given territory. The institutions that exercise this power determine the rules of the game and endeavor to enforce them.

Some key policies have a direct link with food security.

- concerning national food production,
- domestic and foreign trade
- the constitution of stocks.

In some countries, POLitical policies have created a spiral to food insecurity by creating the following effects

- changing wealth redistribution practices weakened purchasing power
- decline in the revenues of businesses,
- decline in domestic production,
- increase in the level of debt,
- widening of technological gaps,
- reduction in reserves,
- increase in low quality imports, and so on (Giroux 1995).

An imbalance between imports and exports often means a country must resort to international food assistance. This confirms its POLitical and ECONOMIC dependence. Other fields of international politics which can have effects on food security include

- the declarations concerning human rights,
- respect for the environment
- exploitation of natural resources
- cooperation,
- international solidarity
- refraining from unilateral measures that are against international law and the United Nations Charter (European Community 1995, Asenso-Okyere et al. 1997, Phélinas 1991, Lehman 1996).

International POLicies do not always have an impact on national situations. Their efficiency depends on numerous factors

- the willingness of countries to participate in these exchanges,
- the availability of discussion sites,
- the ability on the part of national participants to negotiate and defend their interests,
- the ability to implement these POLicies.

National POLicies also influence the food security balance of populations.

- POLicies concerning exports and imports permit control over production activities.
- Export POLicies establish quality, quantity and cost criteria in keeping with demand and international trade agreements.
- Commercial protection manages flows of imported food.

The ability of a population to meet its needs — including food-related ones — can be increased by POLicies relating to

- access to health care and education,
- the fight against poverty,
- social assistance,
- controlling fertility (Benbouzid et al. 1995, European Community 1995, Franqueville and Prudencio 1991, Asenso-Okyere 1997, Delgado 1991).

In the Arctic, the following international POLicies have affected the food supply:

- international decisions concerning whaling,
- the hunting of migratory birds and seals
- interruption of the hunting of marine mammals for fur as well as meat.

At a national level, territorial rights acquired through negotiations between Aboriginal groups and governments may guarantee access to the resources traditionally needed for food. However, access to resources does not necessarily mean that local populations will use them. The right of first refusal concerning the development of outfitting establishments in Nunavik granted to the signatories of the James Bay and Northern Québec Agreement could be legally contested, if a non-Inuit entrepreneur wanted to develop this industry (Otis and Melkevik 1998).

### CULTURE (CUL)

CULTure, as a way of understanding the world, is a basic condition of food security. Indeed, it gives meaning to material existence. As a result, cultural characteristics influence food security.

The resources of an inherited CULTure may keep alive the knowledge of traditional activities and promote a customary use of local resources. This ability meets a portion of the food needs and limits reliance on outside resources. Formal recognition of CULTural characteristics by political powers may promote preservation. (Le Normand 1996: 93, Wenzel 1991, Lynge 1992 quoted in Freeman 1997: 8, Lehman 1996: 1).

However, CULTural traits can lose value. Literacy promotion and education have several effects.

- They open new avenues to transform the world and ensure that needs are met.
- They increase freedom from the constraints of nature.

Literacy and education make it possible to increase knowledge

- concerning health and nutrition, (Benbouzid et al. 1995: 48),
- child development (World Summit for Children, N.Y. 1990), and
- mastering fertility (Benbouzid et al. 1995: 48).

Education also makes it possible to

- teach consumption models that will protect the environment and available resources, (Lehman 1996: 1)
- promote food products and practices (European Community 1995),
- increase human skills and abilities,

- promote openness to the outside world in order to develop social cohesion and
- create commercial exchanges, and the defence of the right to belong to associations (Droy 1991: 117, Thieba 1991: 102).

The resulting changes in CULTure have other effects.

- The availability of remunerated work increases the consumption of imported food;
- the growth in imports reduces the revenue from home-made goods, destroying this production.
- Families disintegrate as they split up and migrate to find paying jobs (Delgado 1991: 80).

In turn, these phenomena produce new CULTural changes.

In the Arctic, the contemporary CULTure of Aboriginal populations reflects the new conditions of existence. These effects are called westernization or acculturation. There have been calls for the preservation of the persistent elements of Aboriginal CULTures (language, harvesting activities, values) and their environment by international, national and regional organizations (see for example Griffith and Young 1989). If so-called traditional food remains a central element in the discussion surrounding aboriginal CULTure, imported food today represents the greater share of food consumed (Duhaime et al. 1998).

### SUPPLY MECHANISMS (SM)

All of these factors influence food production, circulation and consumption in the Arctic. In the model, food production and circulation are grouped under supply mechanisms. These mechanisms are twofold, as the production and circulation may take the commercial route or the non-commercial route.

#### COMMERCIAL PRODUCTION (CP)

Food production is the activity that brings together the necessary factors, work, capital and resources, to transform nature and obtain food products therefrom. Food production is commercial when the interactions between the factors are settled by legal currencies.

Commercial food Production is influenced by factors such as

- ENVironmental conditions (Paulson and Rogers 1997),
- the state of transportation corridors (Benbouzid et al. 1995),
- available TEChnologies,
- POLicies (Lehman 1996), and



- CULTure in relation to production (Bernard and Hoffman 1991, Droy 1991: 117-127).

Generally favorable factors have two effects.

- Food production is sufficient to circulate a food supply that contributes to food security.
- Food production generates profits that can be reinvested in production or other economic activity (Denis 1996: 98, Le Normand 1996: 1, International Food Policy Research Institute 1995, Dyson 1994).

When the factors are generally unfavorable, production possibilities, profitability and revenues all decline. The food production made available for circulation also diminishes, which is unfavorable to food security.

There is organized Commercial food Production at the local, national and international levels. Local production is intended for local consumption and lies with local entrepreneurs. Highly technical production requires non-national capital and is fostered in the global market. This production is often intended for international circuits. Imported production is concentrated in the hands of foreign capital (Le Plaideur and Moustier 1991). Technical production and imported production determine the dependence of a country, a region or a locality on the outside world (Salazar de Buckle et al. 1989, Gaburici 1995). Commercial Production may be sustainable if

- it meets local needs,
- it is controlled locally
- the profits are controlled at the local level,
- the profits can be re-invested on site (Kachondham 1995, International Food Policy Research Institute 1995).

### NON-COMMERCIAL PRODUCTION (NCP)

Food production is non-commercial when the interactions are not settled with legal currencies. This involves household production intended for their own consumption, even if the production uses, for example farm tools, firearms, or motorized vehicles that have been purchased. Non-Commercial food Production occasionally operates at the level of the extended family, the neighborhood or the locality. This may involve, for example, the raising of family herds or the collective hunting of big game. It seldom appears beyond the local level.

Non-Commercial food Production is particularly sensitive to the productive capacities of households. For example, POLitical, legal and ECONomic measures may cut households' access to resources, resulting in a reduction

in the non-commercial production and an increase in poverty (Courade and Peltre-Wurtz 1981). Non-Commercial Production can be encouraged by conditions that are unfavorable to Commercial Production, such as POLicies that do not support purchasing power (Byé and Frey 1995), and the absence of appropriate support and funding (Cheneau-Loquay 1987). This is described as a scarcity ECONomy.

Non-Commercial Production is generally abandoned when the members of the household turn to Commercial Production or wage-earning work (Chastanet 1991, Paulson and Rogers 1997). It is difficult to return to Non-Commercial production if, for example, the market economy does not manage to provide sufficient revenues to households (Freeman 1997, Cannon 1995). In the North American Arctic, hunting and fishing are still practised, but the harvest is rarely commercialized. As a result, a large portion of the consumption of locally produced food comes from Non-Commercial Production (Duhaime and Chabot, ms.).

#### COMMERCIAL CIRCULATION (CC)

Food circulation is the exchange of food production between ECONomic players. The circulation is commercial when the exchanges between the ECONomic agents are settled by legal currencies. The main form of Commercial food Circulation is the sale of food through stores. The circulation of food is organized in supply networks which may include

- producers of foodstuffs, who furnish the supplies
- intermediaries who distribute products, organized by the food products or the services that they offer.

Food circulation is influenced by

- the state of transportation corridors (Benbouzid et al. 1995, Bernard and Hoffman 1991),
- available TEChnologies,
- ECONomic practices (generalized use of currency in exchanges),
- POLitical and social stability
- a state of peace (D. Maxwell 1996: 5, Le Normand 1996, Brunel 1998, Dyson 1994),
- property rights (access to territory and to resources; Cannon 1995: 137), and
- CULTural practices (Freeman 1988).

State POLicies may systematically favor small local producers, large na-

tional producers, or international producers. The resulting circulation may or may not promote food security.

Commercial Circulation of food supplies can contribute to food security by creating stocks that will

- smooth out fluctuations in consumer prices
- meet consumption needs when production drops,
- reduce the migration to cities by heads of families in search of food.

Poorly organized Commercial Circulation often creates an irregularity of supply by allowing

- the invasion of the markets by imported products (Lehman 1996)
- smuggled products (Franqueville and Prudencio 1991: 33, Kermel-Torres and Roca 1991: 46, Phélinas, 1991: 67).

These in turn will

- put the circulation of foodstuffs produced locally at a disadvantage,
- jeopardize the operations of local producers,
- increase dependence on foreign markets
- multiply the chance of conflicts (Denis 1996).

Food circulation between the members of a family is not generally subject to the rules of commercial exchanges. Non-Commercial Circulation is still the rule here, even if the food is, for the most part, purchased in the markets.

In the Arctic, food circulation is organized in regional or national networks. These go from the South, where producers, brokers and wholesalers are located, to the North, where retail stores sell food to consumers (Lawn and Langner 1994). Occasionally, Northern producers sell their products to brokers or wholesalers in the South. Food circulation then contributes to the food security of the North by ensuring wages and profits for economic agents in the North. This income is then available for savings, re-investment, or consumer spending.

### NON-COMMERCIAL CIRCULATION (NCC)

Food circulation is non-commercial when exchanges between agents are not settled by legal currencies. Within the household, food exchanges with no payment in return are the most common form of Non-Commercial Circulation. Within nations, regions, and localities, charitable or state-run institutions may organize the free distribution of food in response to

- the effects of a crisis,
- a localized natural disaster,

- urban poverty,
- people excluded from development (Delgado 1991).

At the global level, international organizations and national governments set up food aid in response to

- the effects of a crisis,
- a large-scale disaster, famine, or war,
- long-term scourges,
- the widespread poverty of a given region of the world.

Non-Commercial food Circulation is always organized in more or less complex and multi-branched networks.

Within the family, the Non-Commercial Circulation of food is subject to numerous determining factors, such as the sexual division of roles (European Community 1995, Savadogo et al 1995), and may not ensure the food security of each member of the family. Practices such as bartering and reciprocity are occasionally adopted by populations as a way to cope with the disintegration of local ECONOMIES (Delgado 1991: 80).

Non-Commercial Circulation can contribute to food security (Akindès 1991). However, volatile social and POLITICAL determining factors at the national and international levels may mean that food security is only temporary (Byé and Frey 1995: 131).

In the Arctic, Non-Commercial Circulation thrives. At the household level, it is the general rule for the distribution of food supplies, either bought or produced, between family members. At the local level, networks play an important role in the Non-Commercial Circulation of food, mainly from hunting and fishing. At the national level, Non-Commercial food Circulation may include

- game redistribution in the Canadian North funded by central governments and managed by local governments (Barrett 1994, Duhaime 1990, Feit 1982, Simard et al. 1996),
- food banks and food exchanges organized by non-governmental organizations.

There are many documented food production redistribution practices within households or localities and occasionally between localities (Condon et al. 1995, Dahl 1989, Freeman 1988, Quigley and McBride 1987, Smith 1991, Wenzel 1991).

## THE CONDITIONS OF FOOD SECURITY, OR OUTPUTS (OUT)

The fact that food is produced and circulates is not enough to meet the population's needs. The additional factors needed for an accurate assessment

of food security are the availability and accessibility of food. These work together to determine the acquisition of food and the actual consumption by the population. On the basis of this actual consumption, it is possible to assess food security.

### AVAILABILITY (AVA)

AVAILability depends on the ability of producers of food goods (production) and services (circulation) to make adequate supplies for consumers. It corresponds to “supply” in ECONomics, the quantity of products actually offered for consumption. Supply, however, generally only refers to Commercial Production and Circulation.

AVAILability is influenced by many factors. The commercial AVAILability of supplies is determined in particular by the ability of producers of goods and services to reach consumers geographically (Le Normand 1996: 88, Le Plaideur 1991: 151, Franqueville 1991: 31). A vast production in one area is only available if it is transported to the regions and localities where the population can acquire these goods.

### ACCESSIBILITY (ACC)

ACCessibility to the food supply is determined by the population’s ability to acquire the supply made available on markets. It corresponds to “demand” in ECONomics, the quantity that the final consumers have the material and financial means to acquire. Like supply, however, the concept of demand generally only refers to Commercial Production and Circulation..

ACCessibility is influenced by many factors. A supply that is AVAILable at the right place and at the right time may not be ACCessible because the prices are beyond the population’s ability to pay (Salazar de Buckle 1989: 8). The supply may be ACCessible because it is affordable; but satisfy only a portion of the food needs, either in quantity or in quality (Kachondham 1998, Gaburici 1995, Cannon 1995, Froment and Koppert 1991). As a result, the relative ACCessibility of supplies is a necessary but not sufficient prerequisite for food security (Le Normand 1996: 88).

### CONSUMPTION (CON)

CONsumption is the final use of food products and services. It takes place when the supply is acquired by individuals, ingested and then metabolized. CONsumption determines the nutritional state and, to a large extent, the state of health (Benbouzid et al. 1995, Bertrand 1997).

Adequate CONsumption may be defined as the satisfaction of nutritional needs with a quality and quantity of essential nutrients that permits a healthy

and active life. The satisfaction of subjective needs can improve the perception that individuals have of food CONsumption (Le Plaideur 1991: 147, Freeman 1988). An example of this would be the ability to satisfy individual tastes and food preferences where the supply is abundant and easily accessible.

CONsumption is strongly influenced by factors that determine the condition of individuals:

- the ECONomic system in which they find themselves,
- the POLitical regime that determines their rights and their duties, and
- the Social STRatum to which they belong.

The ability of an individual to meet his nutritional needs is, all things being equal elsewhere, determined by his state of health. Health determines the biological capacity to ingest and metabolize food, a function that is necessary for the development and preservation of life.

Adequate CONsumption, ensured over a long period, for all individuals and in a fair manner, defines sustainable food security. CONsumption can be less or more than needed. It can be useless or impossible when the individual's state of health restricts his ingestion and absorption capacities.

Under-CONsumption may result from

- an interruption in supplies (for example in the event of ecological disasters, economic crisis, war),
- the inaccessibility of supplies (for example, in the event of poverty or exorbitant prices), or
- individual inability to ingest and metabolize available and accessible supplies (for example, case of severe malnutrition or serious illnesses).

Over-CONsumption may result from

- the ingestion and absorption of food quantities that exceed the needs of the organism (for example, ingesting too much fat),
- the ingestion and absorption of foods of inadequate quality to meet the organism's needs, or
- foods having characteristics or elements that are detrimental to the organism (for example, the absorption of persistent organic pollutants through the consumption of game).

Over-CONsumption appears in a context where food supplies are available and accessible but is affected by the information consumers have to

- make their choice,
- adopt a diet that meets their food needs, or

- avoid superfluous foods or foods with toxic loads (Kachondham 1995: 5, Dyson 1994: 430, Froment and Koppert 1991).

Malnutrition results from under-CONsumption or over-CONsumption that does not meet nutritional needs. It leads to a deterioration in health conditions and reduces the possibility of leading an active life (Gaburici 1995, Kachondham 1995: 5).

Under-CONsumption, often observed in the past, is thought to be still present in the Siberian and Canadian Arctic. Over-CONsumption is present in the North American Arctic, as shown by pathologies related to diet, obesity and cardiovascular diseases for example (Delisle et al. 1994).

### FOOD SECURITY (SEC)

Food SECurity is the capacity of human beings, as individuals or as a group, to consume food to meet their needs. We propose four categories on a continuum ranging from greater security to lesser security. These are

- Sustainable Security (SS),
- Relative Security (RS),
- Relative Insecurity (RI),
- Chronic Insecurity (CI) (Figure 2).

**Figure 2. Categories of Food Security**

	<i>Strong resistance to fluctuations</i>	<i>Weak resistance to fluctuations</i>
Balance between needs and resources	1-Sustainable Security	2-Relative Security
Imbalance between needs and resources	4-Chronic Insecurity	3-Relative Insecurity

Food insecurity results when the balance between the needs and the system's resources is upset, Relative Insecurity exists when the food system has a low resistance to fluctuations in its components. In adapting to these fluctuations, the food system may move from Relative Insecurity to Relative Security, or to Chronic Insecurity. Chronic Insecurity exists when a weak food system strongly resists fluctuations in its components, maintaining the imbalance that characterizes it (Davies 1996, Savadogo et al. 1995, Le Normand 1996).

### FEEDBACK (FEE)

FEEdback is the influence exerted by a component of the system on any other element. This influence modifies the element in question, which modifies the entire food system. A given state of security produces FEEdback and

a subsequent modification in the food system. The feedback may take several forms, the most common ones being reaction and adaptation.

REAction or REAction mechanisms (REA) are short-term practices that modify food security or insecurity. They seek to counter the effects of crises or unfavorable circumstances. This may involve, among others,

- increasing food production,
- boosting revenues through new activities,
- soliciting aid from social networks.

A large range of FEEdback mechanisms promotes a strong resistance to fluctuations, whereas a limited range of FEEdback mechanisms promotes a low resistance to fluctuations.

ADApTation or ADAptation mechanisms (ADA) are long-term practices that modify food security or insecurity. They counter the effects of unfavorable structures. ADAptation is not necessarily deliberate FEEdback. It may call upon

- genetic factors such as size
- physiological factors such as fertility, growth, metabolic adaptation
- reduction in physical expenses
- changes in the activity which supplies the revenue or food (Le Normand 1996, Davies 1996)

The capacity to use FEEdback and ADAptation mechanisms is a major determining factor in the improvement, preservation or recovery of food security. It depends on several variables, such as

- diversity of the modes of access to food resources,
- variety of available networks,
- availability of capital,
- the perception of risk, which varies by education and culture,
- choices made according to resources and the perception of risks (Benbouzid et al. 1995, Kachondham 1995, Le Normand 1996, S. Maxwell 1996, Savadogo et al. 1995).

FEEdback may take place among any one of the basic elements: INPut, Supply Mechanisms, or OUTput.

## DIMENSIONS OF THE MODEL

### FIRST DIMENSION: SPACE OR THE LEVEL OF ANALYSIS

It is no longer adequate to assess food security with the study world stocks, as suggested by the perspective of the World Food Conference of 1974



or that of the United Nations in 1975. It is necessary to examine the interrelations between numerous factors from the international level to the individual level.

There are also interrelations between the levels of analysis. For example, international economic structures (such as the World Trade Organization) influence the mechanisms that a nation implements for food production (such as its business subsidy policies). National production influences the supply of regions and localities. The social policies of transfer payments to households influence the economic capacity of households to gain access to supply and to consume (Davies 1996; Maxwell D. 1996; Rouffignat 1997). The distribution of the power within a household influences the food which each member of the household can consume (Abbi et al. 1995, Dyson 1994). The model must reflect this multiplicity of levels and is organized into six levels of analysis: global (G), national (N), regional (R), local (L), household (H) and individual (I) (Figure 3).

The internal components of each level of the model have identical names at all levels, although their content, referring to different realities, may vary considerably from one level to the next.

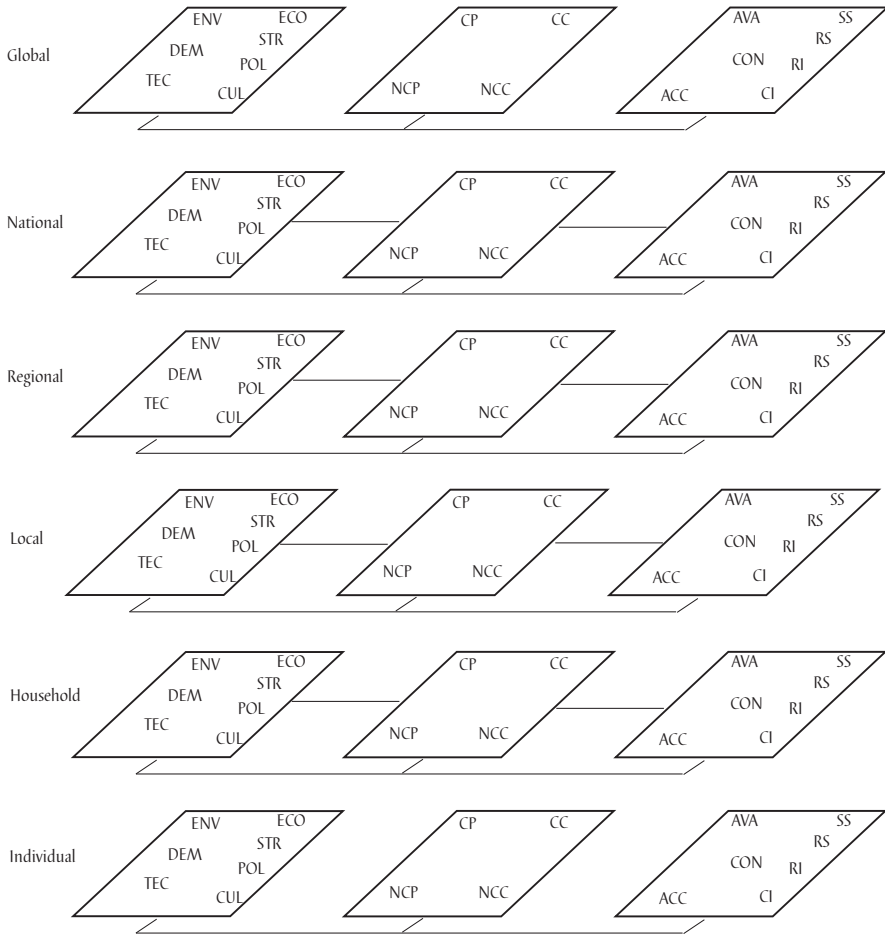
- At the global level, they refer to global food stocks and cross-border transactions.
- At the national and regional levels, they refer to domestic production and to the circulation of the supply resulting from domestic production or imports.
- At the local level, they refer to production realized on site and to local supply networks.
- At the household and individual levels, they refer to the productive activities carried out by households and to the rules for the circulation of supplies between members of similar households.

## SECOND DIMENSION: TIME

This model can document food security at a given time, in a given geographical area, by considering the multiple influences between the variables considered. By repeating the analysis at different moments in time (T1, T2, etc.), the model takes into consideration variations in the variables studied, and may lead to a different assessment.

Moreover, if an analysis identified the environmental contamination of local food production as a factors determining food insecurity, it might be controlled by

**Figure 3. Levels of Analysis of the Food System**



Note: All of the components, the interrelations and the levels are situated in the natural environment underlying the model. To facilitate the reading of the graphical representation of the food system, we indicated the ties between the basic elements of the cybernetic core at each level of analysis, but we have not reproduced all of the ties that may exist between all of the components of each level, and between the components and the levels.

- eliminating the environmental contamination (by strict legislation at the appropriate level),
- circumventing the problem of exposure to the environmental contamination (by modifying dietary habits).

Similarly, if an analysis identifies the lack of monetary resources of households as a major factor in their relative food security or food insecurity, it might be controlled by

- increasing the monetary resources of households (by improving the social security system)
- lowering consumer prices (through business subsidies).

This makes the model a useful tool. It can identify conditions that, acted upon, will modify the situation. With further development, it will simulate the impact of suggested changes.

### INTERRELATIONS AND INTERINFLUENCES

The relations between the system's components are multidirectional, composed of an entanglement of inter-influences (Davies 1996, Dyson 1994: 147, S. Maxwell 1996). A correct analysis of food security cannot ignore, for example,

- the influence of population structure on the economic situation *and vice-versa*,
- that the rights granted to a given population can modify the social stratification *and vice-versa*,
- that the state of health can have an effect on access to the supply and on consumption *and vice-versa*.

A detailed analysis of the conditions of food security assumes that one takes this set of inter-influences into account. We will examine a couple of them here, not to deal with the subject exhaustively, but rather to illustrate the need to take these entanglements into account.

### THE ENVIRONMENT AND THE FOOD SYSTEM

Natural conditions (ENV) are never absolute deciding factors of food security. However, the viability that the ENVironment offers populations is a fundamental condition of food security. An unhealthy ENVironment may result in diseases directly, or through its impact on food security.

ENVironmental conditions can be modified by human activity at the local (L) and planetary (G) levels. At the local level, an intense use of resources that does not respect the physical limits of the environment leads to ruin (ECO).

- The over-use of resources, fertilizers, or water causes
- the desertification of fragile zones,
- the destruction of forests,
- the disappearance of species or
- the decline in the fertility of the ENVironment (Denis 1996: 98, Speth 1993 quoted in Gürkan 1995, Whiteford and Ferguson 1991).

At the planetary level, ecological conditions may also be modified by the effect of human activity, more often than not in developed countries. Climate changes and variability, the destruction of the ozone layer, the erosion of biological diversity, of genetic diversity and the various forms of environmental pollution, including man-induced disasters, affect food security by modifying or reducing access to and the possibilities for use.

### DEMOGRAPHY, HEALTH AND THE FOOD SYSTEM

Strong population growth produces an imbalance between the population, the production capacity (GP and NGP) and the environment's carrying capacity (ENV) (European Community 1995, Minvielle 1991: 183). A major demographic decline results in a serious labour supply shortage, which affects resource use systems (GP and NGP) and the efficiency of existing supply mechanisms (Chastanet 1991: 141). These two contrary phenomena of growth and decline produce an imbalance between the needs of the population (CON) and its capacity to obtain supplies (ACC). This imbalance results from an insufficient quantity of appropriate resources to maintain stability or to maintain symmetrical growth between demography and development.

Nutrition is a major deciding factor in health and demographic characteristics (Bertrand 1997, Benbouzid et al. 1995, Dyson 1995). Adequate nutrition (CON) is promoted by

- a sufficient standard of living (ECO),
- adequate access to health services, (Giroux 1995: 4, Le Normand 1996: 89),
- the application of appropriate hygiene measures and
- education (POL) (Arnold 1981 quoted in Froment and Koppert 1991: 201, Bertrand, 1997: 7).

However, adequate nutrition assumes the availability of healthy food (AVA) and a sufficient, quality diet (ACC) to meet the needs of each person (CON). This is the definition of food security.

Therefore, health and demographic stability are conditions of food security. Food insecurity frequently gives rise to problems such as

- a general state of health and welfare that is poor or bad;
- mental complaints such as stress which also create poor physical health (DEM),
- a reduced reaction capacity of individuals (REA) (Bertrand 1997).

On a large scale, this can be reflected by variations in the productive capacity, by an increase in subsequent food insecurity, and by demographic

changes, such as morbidity, mortality or migration (DEM) (Chastanet 1991, Giroux 1995).

Access to health services is a factor of prime importance (DEM). It allows

- vaccination,
- the fight against infectious and parasitic diseases,
- an appropriate intake of micronutrients,
- birth control, etc.

Moreover, health and nutritional education make it possible to transmit vital information concerning good dietary and health practices (Benbouzid et al. 1995: 48). In this respect, women play an important role in attaining a food balance, a role that is largely recognized around the world. (European Community 1995: 1).

### TECHNOLOGY AND THE FOOD SYSTEM

TECHnology is part of all aspects of a region's development, and the food security of the population appears to be linked to the wise use of TECHnology for the use of natural resources (Kermel-Torres and Roca 1991: 48). Indeed, limited or absent TECHnology caused by

- the absence of usable and profitable natural resources (ENV),
- the absence of the support of producers (insufficiency of financial means, debt) (ECO, GP), or
- a lack of openness on the part of the populations

leads to stagnation or a decline in local food production (NGP), and a lack of processing and storage capacities (CC). These reduce food security (Bernard and Hoffman 1991: 88, 94; Minvielle 1991: 183; Giroux 1995: 9; Kermel-Torres and Roca 1991: 47).

### SOCIAL STRATIFICATION AND THE FOOD SYSTEM

Being a member of a social STRatum, which influences food security, is itself subject to determining factors. Courade and Peltre-Wurtz (1991) surveyed the zones where poverty and food insecurity are found. They mention

- marginal climate zones (ENV),
- under-populated (DEM) zones, and
- zones inhabited by people who live in the country but have no land (ECO).

Favorable economic and political measures help to ease the unequal distribution of resources and powers that produce unequal access to food resources (Dyson 1994). These measures can be

- the recognition of rights,
- improving health care and education,
- strengthening productive capacities,
- an adjustment towards a fair distribution of revenues,
- increasing the purchasing power,

They must counter highly integrated behavioral models and CULTural convictions, that resist changes (CUL) at all levels (Thieba 1991: 103, Droy 1991: 117, Denis 1996: 100, Lehman 1996: 1). These measures are not sufficient to counter major trends, such as

- the deterioration of macroeconomic conditions (ECO) associated with political changes (POL) (Lewin 1998, Giroux 1995), or
- the structural adjustments imposed on developing countries by international agencies (ECO) (Denis 1996: 99, Courade and Peltre-Wurtz 1991: 3, Chossudovsky 1998).

Such conditions create a decline in social security measures (POL) and deep-en inequalities (Kachondham 1995: 5).

#### THE OTHERS

This model suggests that the variables of food security are interrelated, and that their reciprocal influence must be taken into account. This applies to the ENVironment, DEMography and health, TEChnology and social STRatification as well as other factors of the social and food systems. Our project is to develop a three-step process, using this model. We intend to evaluate each of these variables, study the effects of changes, and learn how to predict the effects of change ahead of time.

A square matrix of the theoretical interrelations at one level between the components sketched here produces 324 possible intersection zones between the components (18 X 18). Our matrix must be six times bigger, or 1,944 cells (18 X 18 X 6) to take into account the conceptual differences present in the six levels of analysis. Each of the intersections may have information on the relations between the components. Each of the relations between the components, documented at the intersections, can have an influence elsewhere in the matrix.

### APPLICATION POTENTIAL

The following is a summary of an analysis our model permits. We use an example from the past because it involves relatively well-known situations.

Nunavik, in the era preceding the construction of permanent villages, suffered from the following conditions.

- The constraints imposed on food-producing activities (M-NGP, M-NCC) were numerous and cumbersome.
- The cold climate forced the inhabitants to resort to the harvest of fish and game to ensure their survival (R-ENV).
- Caribou herds were rare and few in number (R-ENV).
- The population was dispersed in small nomadic groups (L-DEM).
- The life expectancy of persons was low, and vulnerability to new diseases was high (L-DEM).
- The activities ensuring survival were based on a low productivity technology, in particular, land transportation (dog sleds) (TEC).
- While the economic organization was largely barter (L-NGP, L-NCC), the fur trade (G-GP) provided some monetary revenues (L-ECO), for purchasing basic consumer goods (L-ACC).
- There was little social support under the political organization (POL).
- The scarcity of game and low productivity of hunting made it difficult to acquire income, commercial goods (L-ACC) and the food necessary for survival (L-ACC, L-CON).
- The deficient food supply made the population vulnerable to diseases, which further weakened the productive capacities of individuals (L-DEM).
- Epidemics worsened the chronic food insecurity situation (CI).

This situation resulted in return actions (FEE) with multiple impacts on the food system.

During the 1960s, the political authorities (N-POL) reacted to the situation by beginning to build permanent villages. They were prompted to take action

- by pressure exerted by merchants (N, R-ECO) and missionaries on site (N, R-CUL),
- by doctors who ascertained the seriousness of the situation (R-POL), and
- by the imperatives of Canadian sovereignty in the Arctic (G, N-POL).

With the permanent villages came

- regular medical care (R-POL),

**Matrix of Interrelations between the Components of the Food System**

Columns	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lines	ENV	DEM	TEC	ECO	STR	POL	CIIL	GP	NGP	CC	NCC	AVA	ACC	CON	SS	RS	RI	CI
1-ENV																		
2-DEM																		
3-TEC																		
4-ECO																		
5-STR																		
6-POL																		
7-CIIL																		
8-GP																		
9-NGP																		
10-CC																		
11-NCC																		
AS-AVA																		
13-ACC																		
14-CON																		
15-SS																		
16-RS																		
17-RI																		
18 CI																		



- schools (R-CUL),
- the gradual generalization of wage earning (R-ECO) and the
- systemization of social assistance (R-POL).

The increase in the economic capacities (R-ECO) and the improvement in the health of the population (R-DEM) made it possible to gradually improve the diet (R-CON); the situation entered a phase of relative security (RS). However, some households had more difficulties than others because they did not have the same access to monetary and wage-earning resources (M-ECO, M-STR). They were in relative insecurity (M-RI).

This example illustrates the usefulness of the conceptual framework for taking into consideration a vast series of components that have an influence on food security. Applied to the present situation, it would force the analyst to consider the impact of factors such as

- technological transformations (use of the snowmobile for food-producing activities),
- the strengthening of social stratification,
- the role of government aid programs associated with hunting and fishing activities,
- the appearance of health problems related to changes in life styles, and
- environmental contamination affecting game in particular.

## CONCLUSION

Major developments in methodology are required before this model can be used to make valid assessments of situations by measuring variables. The development of this model has several steps.

- An examination of each factor of the social system, each supply mechanism and each condition of food security, to create a list of variables
- An examination of each of the variables to draw up the list of the variations that these variables may exhibit.
- An examination of the interrelations of variables and of categories of variables to know the final impact on food security.

In reality, each component of the model represents a field of knowledge, like the “commercial production” or the “political” factor. If, from a methodological standpoint, each component can be compressed into a two-position variable, the result is a superficial understanding of the underlying processes, not full comprehension.

We can, however, examine in what way, and under what conditions, each component of the model contributes to sustainable food security. This will create a standard ideal or a yardstick. Studying a situation from all necessary angle simultaneously, and placing the results against this yardstick will show which variables need change. This is the best hope for our continuing work.

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