Decision Support Systems in Facing Food Insecurity Challenges

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Palestine Economic Policy Research Institute
MAS

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Foreword

In recent years, a sizeable portion of the population of the West Bank and Gaza Strip have been living under conditions of severe hardship. They have been subjected to both a disruption of their economic activities and a loss of control over their natural resources. This has resulted in almost one third of the population living in a situation that is characterized by food insecurity.

This study considers various policy options directed at mobilizing existing resources in an efficient manner so as to create a decision support system (DSS) capable of insuring food security.

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Dr. Mohamed Nasr
Director General

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Acronym Reference List

ARIJ	Applied Research Institute-Jerusalem
CFSVA	Comprehensive Food Security and Vulnerability Assessment
CIF	Cost Insurance Freight
CP	Compromise Programming
CROPPAT	Cropping Pattern (software package)
DM	Decision Making
DRC	Domestic Resource cost Coefficient
DSS	Decision Support System
Du	Dunum (= 0.1 ha = 1000 square meter)
EPC	Effective Protection Coefficient
FAO	Food & Agriculture Organization
FEWS	Famine Early Warning System
FIS	Food Information System
FIVIMS	Food Insecurity & Vulnerability Info. & Mapping System
FOB	Free On Board
FS	Food Security
GIEWS	Global Information and Early Warning System
GM	Gross Margin
JOD	Jordanian Dinar (Currency: 1 JOD = $1.4)
LP	Linear Programming
MAS	Palestinian Economic Policy Institute
MIS	Management Information System
MOA	Ministry of Agriculture
MOLP	Multi- Objective Linear Programming
MOTAD	Mean Of Total Absolute Deviations
NLP	Non-Linear Programming
NPC	Nominal Protection Coefficient
ODI	Overseas Development Institute
PA	Per Annum
PAM	Policy Analysis Matrix
PCBS	Palestinian Central Bureau of Statistics
PPP	Purchasing-power Parity Price
PSERM	Palestinian System for Environ. Resources Management
SCB	Social Cost Benefit Ratio
WFP	World Food Programme

Executive Summary

2006 data show that 34% of the Palestinians in the West Bank and Gaza Strip face a state of food insecurity; moreover, 12% of them face this risk, especially in rural and marginalized areas. The suffering is different from one place to another based on each place's factors of survival on natural resources, job opportunities and other resources. It should however be noted that the measures of the occupation, including closure, land confiscation, barriers and others, still constitute the major cause of deteriorating food security of Palestinian households.

Although facing food insecurity has been listed on developmental action agendas for years, achievements are still limited in reason of failure of programs and policies in identifying the real problem and recruiting or employing the resources in projects that produce sustainable development and food security. To the contrary, some of these projects come as an adoption or patriarchal relation with the marginalized in terms of food provision to the extent that some beneficiary groups grew too dependent on assistance that they do not mobilize their capacities, resources or assets to realize higher levels of food security with their own effort in a more sustainable manner.

The cost of producing more food security could cost less if such resources are used more effectively and more cautiously with more belonging and if decisions, data and programs are knowledge based.

Humans make unlimited number of decisions every day that clearly affect their financial status and accomplishments. Some of these decisions are uninformed and lack the necessary research; others require more time and effort to assess risks. In general, the more important, dangerous and complicated decisions are, the more they require time and effort, and the more information and information analysis becomes primordial to support or correct the decision. Since decision making is a process of choosing among alternatives, it is necessary to analyze all options; this means that more information and analysis is needed, hence the emergence of IT systems and templates, provision of raw material (information and data) to facilitate and most importantly, rationalize decisions.

Many obstacles face the use of information, data and knowledge in decision making. Some of these difficulties are related to the quantity and quality of such information (information security); others depend on the capacity to manufacture and use information in the optimal way. Information systems and templates were created to support decision making and facilitate access to information to help in decision making; i.e. absorbing facts and predicting the future by analyzing alternatives to mitigate risk.

There are types of information systems, starting with data tables and matrices up to decision-making support systems, simulation models passing by information systems on the Internet, experts systems, document-based systems, administrative systems and others that link data analysis and geographic information systems (GIS). They vary in terms of their need to data, information, manufacturing or analysis of data and according to users and the objectives they were made for.

The study attempts to answer core questions: Do we need information management systems, and decision-support systems? Which of these systems do we need more? In what context should they be employed? This is especially so if we identify as objective for intervention in decision making the deteriorating and vulnerable food security. In analyzing these questions, the study analyzes four computerized information management systems used in decision making, namely the Palestinian System for Environmental Resources Management (PSERM), Crop Pattern system (CROPPAT), Policy Analysis Matrix (PAM) and Food Insecurity and Vulnerability Information Management System (FIVIMS).

It is worth noting that food security means “accessibility to sufficient and adequate food at all times to have a sound and healthy life”; it involves thus four important dimensions: food availability (local production, trade net and food subsidies); accessibility to food (work, income and support); optimal use of food (preparation, nutrition and health); food stability related to the market and income and price fluctuations.
Effective combating of food insecurity raises a number of questions: who are the food insecure persons and where are they located? What is the nature and frequency of their being subject to food insecurity? What is their context, survival limitations and bio-environment? What kind of risks are they facing? What are their abilities and the nature of their defense strategies?

Many obstacles obstruct effective action in confronting food insecurity including limited production base, failure of institutions, policies and markets, especially in food economy. The lack of information and inability to produce such information as well as ineffective technical levels play a major role in this regard. MIS and decision making support programs ought to expand on these issues and provide knowledge and answers that can help stakeholders and activists make optimal use of the resources available and provide convincing and adequate answers to the questions raised.

Applied research adopts a number of approaches to handle food questions and food economy; they include commodity chain analysis that depend on following a single commodity since it was a seed until it became a final consumer's product. Another approach uses the living factors of households and groups including their resources, abilities and the use thereof a well as risks and confrontation mechanisms. A third holistic, multi-area approach studies the agriculture, education, health and other factors using several expertise to provide a comprehensive investigation of every case for the problem is not restricted to a single field. This gives reference to the significance and multiplicity of intervention fields, information wise. This requires diversified information analysis systems and decision-making support programs with a broad database to handle information covering such issues and decisions. This information will cover all issues related to the agri-production system, market information, data on marginalized groups and nutrition as well as food systems and food assistance. They constitute the early-warning data systems and a source of information to improve decisions related to production, marketing and policies.

Because of the multiplicity of areas of intervention and of targeted groups and information systems users, it is expected that such patterns and data bases will have specific patterns to solve specific problems (production, marketing and others) or holistic systems that cover a number of functionally complementary computerized systems. Some of these patterns provide an in-depth understanding of reality (production, availability, prices and others) while others depend on expertise to read and predict future situations (expected production, availability and prices, spread and evolution of diseases and insects, for instance) and other patterns for comparison (vertical and horizontal).

It is worth nothing that notwithstanding the importance of using computerized data and patterns to support decision making and simulation templates, the integration of such patterns and information system is still limited and insufficient for many reasons:

- ✧ Obstacles related to policies, institutions and work environment like low commitment to the objectives and policies, lack of awareness of the importance, insufficient coordination in data exchange and information is oriented toward external funding.

- ✧ Problems stemming from availability, quality and coverage of data and information although there is a need for a huge amount of quality multi-source data to establish and employ computerized systems in improving the ability to make decisions.
- ✧ Technical impediments related to integrating MIS and to lack of qualified human resources to manage complex information systems in different areas (sectoral, scientific or technical).
- ✧ Financial obstacles as MIS and computerized data systems need relatively elevated budgets.
- ✧ Information – system related problems as actual simulation of the reality is a complicated process and data and information systems are complex if we wish them to be useful. Moreover, most of these programs personal and academic built for different applications and users other than farmers, agricultural producers or extension experts. They may not be compatible in concerns, understanding and operational ability.

The study reviews four information system that – in a way or another – entered into application in the Palestinian Territory:

PSERM

The Applied Research Institution – Areej – developed this system in 1996 with the objective of identifying the best situation to make maximal use of resources available in a given governorate including arable land and water following specific demographic, marketing and economic data. To serve this purpose, it uses linear programming. Yields of agricultural production of selected crops are used as an objective indicator and are specified (as a maximum) mainly by water available in the governorate, area of arable land and fulfilling of demand on agricultural goods (as a minimum), represented by domestic consumption, imports and exports at the governorate level. The demand is assessed mainly by the size of the population taking into account certain demographic growth scenarios and living standards (revenue) taking into account four scenarios and a specific scenario accounting for the number of returnees into this governorate.

The model covers a specified list of vegetables and fruit trees. It takes into consideration the cost of production, single commodity productivity under four technical practices: open agriculture, low tunnel and high tunnel agricultural, greenhouses and rain-irrigated crops. It also considers the market prices in the governorate

It is worth noting that the model processes annual data at governorate level and relies on field gathering of data as well as information provided by relevant institutions, namely the Ministry and Driectorates of Agriculture and the Palestinian Central Bureau of Statistics.

PAM:

The Policy Analysis Matrix focus on shading light and calculating the indicators related to the ability of domestic products to compete in (international) and local markets in case of trade liberalization and other indicators focusing on the protection and subsidies provided to these commodities, per every commodity or the unfair treatment they face because of the lack of such protection or subsidies (consumers' support, for instance). Hence, they help in reviewing and assessing market performance and the policies affecting the production process, marketing and other elements.

PAM depends on the difference between real prices (applicable) and social prices (shadow prices) calculated on the basis of free market and international prices per every production input and output as well as local resources. Accordingly, cost of resources (real and social prices) as well as cost of local resources (real and social prices) and sales (real and local prices) are computed to calculate the real and shadow profit and transfers in between them.

CROPPAT

The CROPPAT came as a result of PhD thesis in 1992. It aims to help farmers in decision making and in planning production at the farm level in terms of employment (distribution) of resources available (land and water) and crops as well as other agricultural production activity. In other terms, it specifies the best cropping pattern.

The CROPPAT considers the possibility that a farmer may have several objectives: maximizing profit, fearing risks, seeking stability of profit, controlling budget, identifying a ceiling for cost and expenditure. For this purpose, the program applies linear and non-linear (risk) programming.

The CROPPAT relies on annual data on cost, prices, revenues, use of land and water, and production; it also considers market prices on monthly basis. The program allows for models to predict monthly market prices using past prices data (time chains of monthly prices); it takes into consideration economic development predictions.

CROPPAT provides best solutions (cropping patterns or land distribution over competitive crops), which respond to the goals of farmers within the context of resources on his/her farm including water supply (on monthly level), land and monthly cost. Farmers may assess the proposed solutions responding to variant objectives to come up with a compromised solution that maximizes the farmer's goal setting.

CROPPAT gives also shadow prices of the resources available for the production process over one month; i.e. the shadow prices of water in September or February, for instance. It also examines the other limitations to production including expected revenue, allocated expenditure budget or available labor force.

With the data output, CROPPAT helps farmers plan for the use of water, land, budget and labor available. The outputs are elaborated in printable reports that help farmers and agricultural extension professionals as well as researchers understand the analytical process and interpret outputs. It plays hence the role of the observer for agricultural extension professionals and decision-makers in general.

FIVIMS

FIVIMS and other similar information systems depend on data on food insecurity and availability of data and information on food insecurity at international and national levels to constitute an Internet information system. It acts as informant on the outspread of food insecurity and aims to assist in analyzing information at sectoral level (production, marketing, consumption, etc.) in addition to reinforcing national human resources abilities in analyzing information on food insecurity and fostering networking in such areas.

FIVIMS creation depends on assessing the needs of every country, hence responding to the needs of decision-makers in terms of information and building on the information available at household level in an effective manner.

FIVIMS covers a number of components that, in turn, constitute information systems: agricultural production information system, marketing information system, health and nutrition information system, early warning information system and climatic predictions information system. Each of these systems covers a number of indicators that help in monitoring the food insecurity situation.

FIVIMS systems vary from one country to another in accordance with their needs and available resources because they depend on the data available to create a comprehensive long-term aggragated system, as reported in literatures.

In the Occupied West Bank and Gaza Strip, and in reason of lack of information, the focus was building human resources abilities in information management and in carrying out surveys on food insecurity. They are currently working on a socioeconomic survey and security networks at household level to help in monitoring this phenomenon and assist decision-makers in formulating policies and devising programs to face the different cases of food insecurity.

The study conclusions were numerous: lack of interest in information and data, both quality and quantity wise, weak exchange of information, poor coordination among institutions working in this field and most importantly, their poor ability to make optimal use of the available information and data; policies and decisions in general are not made on informed basis in all institutions, not to mention farms or production units.

The study also presented a number of suggestions focusing on handling the different dimensions of food insecurity: optical use of natural and human resources and others at country, community or even household levels, focusing in reinforcing competence of use of information, building the capacities of decision makers and information users at institutional and individual levels. This includes understanding the current use of data and information, identifying obstacles and problems that obstruct a more effective use thereof. It also includes suggestions to assess needs in information analysis and assess the impacts of integrating information in the decision-making process at farm a well as policy levels.

1. Introduction

The political climate in the West Bank and Gaza Strip is presently incompatible with agricultural development and food security. With the present rates of population growth and political and security measures, particularly: closure and confiscation of fertile lands, inefficient markets and unfair competition, people increasingly depend on dwindling areas of cropland. They also experience a decline in access to natural resources, as well as other resources. This consequently confronts people, particularly families in rural areas, with questions concerning the very existence of agriculture production and, therefore, often the basis of their livelihood.

In 2006, roughly 34% of the population in the West Bank and Gaza Strip were considered food insecure, with an additional 12%, mainly in rural areas, vulnerable to becoming food insecure (FAO, 2007), (FAO 2003). Communities face different levels of food insecurity depending on several factors, among which are availability of resources, particularly productive and natural resources, and access to sources of income.

Main causes of poverty include: military occupation (embargos at ports and entries); political instability and lack of security (incursions, military checkpoints, violence and a weakness of institutions responsible for coordinating food security activities and monitoring food security).

Despite the fact that food security has been on the development agenda for more than 10 years, only limited progress has been made in achieving food security objectives. Poverty alleviation efforts are less effective in fighting against poverty, instead they imbued with an implicit paternalism towards the poor and peasants, in other words, they reinforce dependency.

An indirect, but nevertheless important problem, undermining sustainable poverty reduction efforts at a national level, is the lack of cultivating (particularly rural) people's ability, awareness of and gradually competence in decision making. This problem arises from continuing to provide communities with ready-made solutions which, in absolute or relative terms, fail to address deeper problems. These 'easy answers' are not sufficiently based on people's assets, capabilities, competence and experience.

There is a need to search for effective and meaningful strategies that are able to break the society's cycle of poverty traps. The overriding problems and constraints require serious and systematic attention and commitment at the highest possible level. International experience shows that all successful large-scale progress against poverty starts with more productive, small-farm, employment-creating activities, especially in food production.

It can be argued that if resources, particularly productive resources base are used and mobilized in an efficient way, then greater and more sustainable food security can be assured. This concerns policy as well as work at the institutional, production and micro levels.

In summary, long term sustainable development and general improvement of livelihood may require less effort but more dedication, and knowledge-based and informed decisions.

In trying to improve food security, this study will try to answer the following questions:

- Is there a need for decision support systems (DSS) or models? If so,
- What decisions should be supported?
- How could these decisions be supported?

The last question is limited to a comparison between a few existing models: PAM, PSERM, CROPPAT and FIVIMS.

In addition to shedding some light on the decision support systems and models in chapter 2 and the appropriateness of decision support systems in food and agriculture issues in chapter 3, the study will make a comparative analysis of a few decision support systems/models. This will include examining: data needs, data processing algorithms, expected results and underlying assumptions. The study will be concluded with findings and practical suggestions.

2. Decision Support Systems: Theoretical Background

2.1 Data and Information

It is worth mentioning here that *data* is the corner stone in building *decision*s and d*ecisions* are the building material of *policies*, which in turn are parts of a *strategy*.

Good policies which lead to success and fulfillment of objectives require, among other things, good and sound decisions. In turn, good and sound decisions require information or to be information and knowledge-based.

In practice, information has not been effectively used in management and planning of many sensitive sectors, including agriculture. Possible reasons for this are that:

- The information provided is not always relevant to decision making. Even agricultural statistics are not tailored for being used in planning interventions. Only recently did the Palestinian Central Bureau of Statistics (PCBS) start producing statistics using farms rather than communities as a statistical unit, the way it was under the Israeli Statistical System.
- The format in which the information is provided is not always well understood by the agriculture and policy making community. Coordination between different data users and producers needs further attention.
- In many situations, there is contradictory data or forecasts that create confusion among decision makers. Produced data and/or information are products which still need to be controlled for quality, reliability and usability,
- Even in the case where successful use of information is possible, policy makers and those people taking decisions do not always make the right choices. There is too little interest, for example, in the optimal use of information in decision making, for which awareness needs raising and capacity, building.

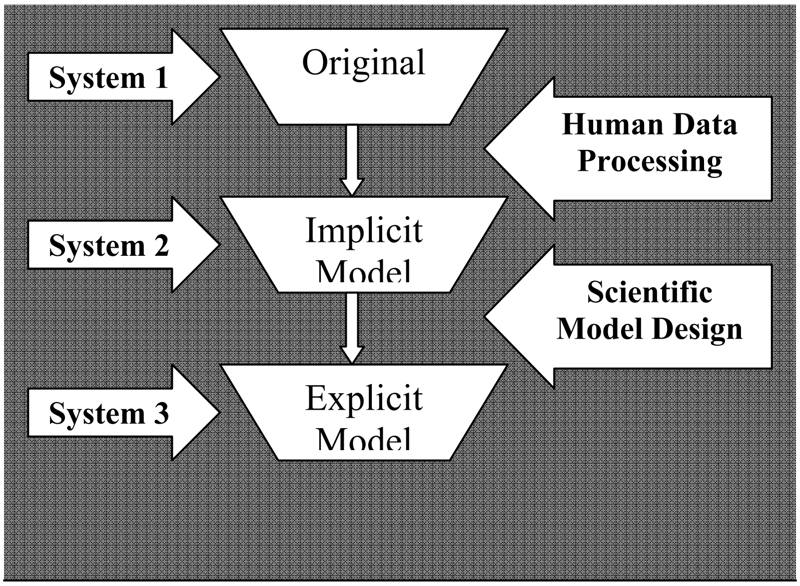
2.2 Decision Making

Decision making (DM) is the process of choosing between two or more alternatives and is based on assessing possible outcomes.

There is quite often little certainty about the consequences of decisions. Forecasts about prices, weather or demand are common examples of what decisions related to farming are based upon. Such predictions are the result of previous decisions made from another set of determining factors.

In solving a problem, individuals naturally turn to a simplified, implicit and subjective model of the situation (system 1 in Figure 1). They do not know the objective reality. The complexity of decisions is not necessarily linked to the complexity of a problem needing solving. To some extent, depending on how expert and informed the decision maker is and also the degree of importance he/she gives to using data.

Figure (1): Two-stage model building (see Schnabl, 1985, P454 from Berg & Kuhlmann, 1993, P7)



Other questions are more important but may not require intensive use of information, only simplified models. Such a model that may never be articulated explicitly (an intuitive model), can work well, providing quick and cheap answers that may confirm initial hypothesis or subconscious conceptual models (compare with FAO 94, 41).

Due to the complexity and uncertainty of factors affecting the system, decision making has become a difficult task and requires evaluating all alternatives. The more complex the situation is, the more time, information and effort is required to arrive at the right decision. The model will also be more complex and more scientific in order to simulate the situation and encompass all elements of the real system. However, there will always exist some trade-off between, on one hand, the decision and its importance, and on the other, the time or cost to process it.

2.3 Decision Related Models

Models are a serious attempt to simplify and abstract the most important states and depict the multidimensional relations of the tremendous number of elements of the real system so that complex causality relationships can be reduced into a more simple and understandable picture (Berg and Kuhlmann, 1993:7).

When a model of real-life system is constructed, uncertainty is usually an important element. Uncertainty originates from: the complexity of the studied systems, the interaction of sub-systems, the lack of precise values, any missing data, limited information processing capacity, or ambiguities. (Passam et. al. 2003)

Furthermore, uncertainty and risks could be directly linked with a model itself, particularly:

- ✧ Basing model parameters on, for instance, information and experience that is out-of-date .
- ✧ Difficulty of precisely assessing the prior state of a situation or system, upon which the model output depends.
- ✧ Stochastic processes in the systems which cannot be accounted for or completely simulated.

2.4 Decision Support

Experience, information, external support and other tools may help the decision making process, improving results. Such aides however are not by themselves sufficient for reaching a right decision. Complex decisions may need additional time, skills and information processing.

Decision support models or systems (DSS) give "refined information or knowledge" that increases the efficiency of decision making (time and cost) and secures the effectiveness and achievement of objectives.

Using the information in DM, irrespective of its or DSS's complexity has effects that increase and improve the following:

- ✧ Performance efficiency (time and cost),
- ✧ Coping with changes and reducing losses
- ✧ The value and appreciation of and for information,
- ✧ Backstopping to research and studies,
- ✧ Bridging the gap between research, information processing, decision taking and policy making process.

Finally, many economists believe that the easiest "economic policy" decisions could become the most expensive ones if important elements of the system are not considered. Decisions such as -direct subsidy in agriculture, protective policies in trade, central planning, and food aid in international development- are good examples of easy but highly expensive decisions, since long term implications are not sufficiently considered.

2.5 DSS Applications

Since 'real-life problems' are multidimensional and involve different sectors and actors, DSS should be concerned with the development and application of the interrelated economic, environmental, and biophysical consequences of alternative policies and scenarios affecting food security (Clarke 2001)

Recent developments in information technology brought about the evolution of computer-based DSS, which couples the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions (Keen and Scott Morton 1978, Wikipedia.DSS.).

Once the question is not "do we need DSS?" but, more specifically, "which system or model?" then two things become important: What is the system for, what is the objective? And, who are the end users or decision-makers? The target group or end users could be, for example, farmers, extension agents, researchers, students or policy makers, or, a combination of them.

DSS is therefore very broad because of the wide range of domains in which decisions are made, because there are many approaches to decision-making and for the many potential users.

2.6 DSS Chronology

As stated above, Decision Support System (DSS) is a general term for any computer application that enhances a person or group's ability to make decisions. They range from simple accounting-based systems to systems based on detailed deterministic or stochastic models. There exist several specific Decision Support Systems, (Power 2000) a number of which are summarized below.

- Communication-driven or Group DSS
- Data-driven DSS
- Document-driven DSS
- Intelligent, Knowledge-driven DSS or Expert system
- Model-driven DSS
- Inter-organizational or Intra-organizational DSS,
- Function specific DSS
- A Web-based DSS
- Spatial-DSS

Communication-driven or Group DSS
This intends to facilitate solutions to problems through decision-makers working together as a group, using electronic communication, scheduling or document sharing.

Document-driven DSS
This helps managers retrieve documents, (about, for example, policies and procedures, product specifications and catalogues). It also assists them to manage unstructured documents and Web pages.

Data-driven DSS
Data-driven DSS include filing and management reporting systems, data warehousing and analysis systems, business intelligence systems, financial planning systems and spread-sheets. DSS for the agricultural sector started as computerized record keeping (Nikkila, 2007) and spread sheets.

Spread-sheets are a large sheet of paper with columns and rows that organizes data on a single sheet of paper for a decision taker to examine when making a decision. The data can be "added-up" by a formula and summarizes information from many paper sources in one place and presents the information in a format to help a decision maker to see the business in a more holistic perspective (D.J. Power),

Policy Analysis Matrix PAM is a good example of spread-sheets or data-driven DSS (see chapter 4.2).

Intelligent, Knowledge-driven DSS or Expert system

Expert-systems are Knowledge-processing programs intended to capture, preserve, use and extend the knowledge of experts. They are computer programs designed to simulate the problem-solving behavior of an expert in a narrow domain or discipline, and suggest or recommend actions to managers.

The primary goal of expert systems is to make expertise available to decision makers and technicians who need quick answers since there is never enough expertise to go around, especially in agriculture, where agricultural specialist assistance is not always available when the farmer needs it.

One of the best applications of knowledge-based DSS in agriculture is called Precision farming**. It** considers the differences between the microenvironments of plants and/or animals.

Model-driven DSS

A model-driven DSS is an interactive computer-based system intended to help managers make decisions. It covers a wide variety of systems, tools and technologies including: systems that use accounting and financial models, representational models and optimization models. Model-driven DSS use data provided by decision-makers to analyze a situation. They are not, however, data intensive.

Model-based DSS are designed to support business and organizational decision-making activities, (www.informationbuilders) and help decision-makers use data and models to solve badly-structured, unstructured or semi-structured problems. (wikipedia.DSS, Spargue and Carlson 1982, Power 2000). They belong to an environment of multidisciplinary foundations including databases, artificial intelligence, human-computer interaction, simulation methods, soft-ware engineering and telecommunications (wikipedia.DSS).

CROPPAT (chapter 4.3) and to some extent PSERM (chapter 4.1) are examples of model-driven DSS.

A Web-based DSS
Unlike DSS stored and based on a personal computer, implementation and updating of web-based or internet-based DSS is more cost and time efficient. In addition, the system developer, owner and users may benefit from the input data supplied by users of the system. FEVIMS and other EWS can be considered as good examples of web-based-DSS (see chapter 4.4).

Spatial-DSS (SDSS)
SDSS supports users or DM in making decisions under complex situations considering special differences (Location and micro-environment). SDSS = GIS + integration of experts systems + additional analytical functional modules.

2.7 Properties of DSS

A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from -raw data, time-series data, documents, personal knowledge and/or business models- in order to identify and solve problems, and make decisions (www.informationbuilders). DSS have four key components:

1. A user interface or dialog generation and management system.
2. A database and database management system. (A successful model must make best use of the available data; see Gehling).
3. A model and analytical tools, or a model-base management system.
4. The DSS architecture and network (Spargue and Carlson 1982 in Power 2000, Wikipedia.Dss).

In the DSS framework according to Wagner and Kuhlmann (1991), DSS is comprised of eight components, namely: databanks, a help statements bank, the Models-bank, the management system for each of previous 4 components, the users' data entry program and the user himself.

3. DSS relevant to Food Security

3.1 Food Security Defined

Food security (FS) can be defined simply, as "having access at all times to enough food for active and healthy life," with no need for recourse to emergency food sources or other extraordinary coping behaviors to meet their basic food needs. (Artz 2003)

The definition of food security above underlines four critical elements:

1. **Food availability** (production + foreign trade + food aid): is achieved when sufficient quantities of food are consistently available to all individuals within a country. Through household production, other domestic output, commercial imports or food assistance (FANTA 1999:8). Food availability = Production + (Imports-Exports) + available stock – losses – uses other than for food (FAO 2000:32).
2. **Food access** (employment, income and food aid: financial, social and physical): is ensured when households have adequate resources, such as income, to obtain appropriate food for nutrition. This also depends on the price of food. (FANTA 1999:8).
3. **Food utilization** (Biological utilization, nutrition, health): is the proper biological use of food.
4. **Food stability:** Transport, prices, market management.

In 2000, The European Commission (EC) tackled the food security issue from a wider perspective. For the EC, food security normally concerns three levels of intervention and involves three key objectives. These spheres of intervention are at:

1. The regional and national levels, where availability of food of an acceptable quality is the key objective.
2. The household level, aiming to ensure access to food by households,
3. The individual level, at which food use and nutritional adequacy at an individual level is the goal.

FAO, (2000a) was more concerned with national, community and individual households' levels in finding that, ‘food insecurity is a complex phenomenon, attributable to a range of factors’. (FAO 2000a:2) These factors can be grouped under four areas:

1. The socio-economic and political environment.

2. The performance of the food economy.
3. Care practices.
4. Health and sanitation.

3.2 Food Sources

Households get their food from various sources. It can be grown (agricultural production); purchased in the marketplace (non-Agricultural income generation); received as a transfer from relatives (transfer); received from the government, an NGO or from a foreign donor (as aid); gathered in the wild (edible, medicinal and aromatic herbs and plants). (FANTA 1999:15)

Improving food security at a household or country level, requires working to ensure efficient, effective and sustainable use of resources, whether they be natural, human, financial or national resources. In countries where the main sector is agriculture, one expects more emphasis and allocation of resources to agricultural production. According to the EC "programmes which promote broad-based sustainable growth and which encourage the more efficient and effective use of natural resources are likely to have the greatest impact on food security." (EC 2000:7)This is highly applicable to the current situation in the West Bank.

3.3 Food Security Constraints

Possible constraints to food security include: (FANTA 1999:15)

- Low and erratic rainfall and limited natural resources, (for example - land degradation, fragmentation and limited water-).
- Poor market infrastructure and an inefficient marketing system (there may be market failure).
- Unfavorable policy and regulatory systems, (policy failure) including micro and macro trade policies.
- Limited access to technologies and financing (credit).
- Weak institutional capacity to respond to inefficiencies and shocks.
- Degradation and deterioration of resources.

A frustrating phenomenon in the West Bank is the lack of synergy between potential agricultural productivity of communities and households and the level of food security, particularly in communities that have at hand rich natural-resources. The overwhelming reality is that most farms only produce a small proportion of their potential. This is the case not only in the rain-fed (Baal) highlands plateau, but also in the 'vegetable basket', the Jordan Valley. Causes of the production gap and weakness need to be explored further.

3.4 What Work

It is important to answer several questions (see black box below) that outline the nature of food insecurity and from which programs and policies for improving food security are based. The questions also aim to improve efficiency and effectiveness of food security programs.

Questions facing Food Insecurity Reduction

- ✧ Who are the food insecure and where do they live?
- ✧ What is the nature, frequency and degree of their food insecurity?
- ✧ What is the nature of their livelihood systems and what kinds and constraints are they experiencing?
- ✧ Who are the vulnerable and where are they located?
- ✧ What is the nature and degree of the risks that they face?
- ✧ What is the nature of their coping strategies in response to these risks, and how effective are they?

(FAO 2000a:3)

The importance of a database and information systems for answering these questions is made clear, as are data-based decisions as a basis for policy making and programming. Precisely, it includes:

1. Identify gaps and needs.
2. Identify resources, services and systems that could be used to fill gaps and meet needs.
3. Provide the basis for a well-constructed action plan that reflects the community's goals, needs and resources.
4. Develop intervention strategies (e.g. types of programs or outreach).
5. Inform decision makers about policies and actions to improve food security (ARTZ, 2003).

All the information assembled can lead to better understanding of decision making among the actors in the food economy and makes identifying the various assets, constraints and possible interventions easier.

This is supported by the Palestinian National Food Security Strategy, which suggested several interventions, improvements and corrective measures to reduce food insecurity. The strategy stressed in many occasions, directly or indirectly, the importance of informed decisions and knowledge-based actions including allocation of resources (water, land, crops…etc.) and capacity building (see Text box 1).

3.5 Approaches

As stated above, food insecurity stems from the smallest livelihood units, at individual and resources level, up to the macro economic policies and natural environment. Improving a food security situation requires a thorough investigation into weaknesses in the system in order to design interventions and an approach. In regards to agricultural production, the following three approaches are common:

- A commodity chain approach,
- A household livelihood approach,
- An interdisciplinary (holistic) approach.

1. The analysis of a commodity chain reveals the relationship between the different actors and should bring to light any constraints that could explain inefficiency in the chain. It should, in particular, help to explain low producer prices (which hinder availability), high consumer prices (which limits access and poor marketing which could lead to unstable supply (FAO 2000:25).

2. The household livelihood approach tries to answer the question: Who are the food insecure or vulnerable population groups? The challenge is to develop a methodology to estimate people's ‘entitlement’ (Sen, 1981). In this context, entitlement essentially refers to the sum of current food holdings and the exchange value of labour and other assets in terms of food [ODI 2002:3].

   The household livelihood approach can discriminate between a number of things, including: between a population with different livelihoods and between poor and rich segments of a population. This approach is important for differentiating geographical, socio-economic and other factors affecting food security and vulnerability.

Box (1): Issues related to Decision support raised in the National Food Security Strategy 2005, (P 79f)

Improving Food Availability through:
Information based land reclamation,
Identify the types of crops to be planted,
Water consumption to identify the best crops,
Use research in determining crops to be planted,

Increase Agric. Productivity through:
Increase use of recycled water in agriculture
Need for market-led agricultural enterprises,
Vocational training for agricultural workers,
Improve extension services,

Additional remarks including:
There is a lack of data and statistics in FS,
Need for efficient extension services,
Promote "Farming as a business".

3. The interdisciplinary (holistic) approach involves: producers of information, scientists from different disciplines, food-economy related stakeholders (farmers, advisors, researchers) and policy makers. Experience shows that as countries develop, the production functions, particularly of agriculture, tend to become overshadowed by the marketing and distribution functions (FAO 2000:26). This increases the importance of tackling food insecurity with a multi-disciplinary and multi-dimensional approach.

3.6 Information Products to Serve Food Security Reduction

Any DSS in the domain of food security has one or more of the following objectives:

- ✧ To increase decision-making related knowledge.
- ✧ To increase the capacity to communicate and utilize information to improve decision-making in agriculture.
- ✧ To foster interaction between providers of information and users in the food-economy.
- ✧ To reform and strengthen policies, local institutions and economic and legal instruments.

The information products that have been used to address food security policy issues can be classified into:

1. Assessing, mapping and monitoring factors affecting food security
2. Analyzing and assessing options and alternatives for reducing the impact on food insecurity
3. Analyzing and assessing options and alternatives to modify production systems.

The first products belong to information systems, while the second and third constitute the core of food security related decision support systems.

3.6.1 Information Systems-based Food security DSS

A good example of this category will be discussed thoroughly in the next chapter, *FIVIMS chapter 4.4*.

A typical food information system concerns the underlying social, economic and institutional factors that affect the quantity and quality of available food and the affordability or price of food relative to the sufficiency of financial resources available to acquire it (ARTZ, 2003).

An example of more specific food security information systems is the Early Warning Systems (EWS), which condenses information relevant to food insecurity. Table 1, below, shows the wide spectrum of an early warning system covering production, marketing, utilization and food economy.

Table 1: Components of a typical Early Warning System

Agricultural production	Phyto-sanitary monitoring Monitoring rainfall Monitoring crops Monitoring animal production Monitoring agricultural forecasts
MIS Commercialization	Price indices Import/export monitoring Monitoring national stocks
Vulnerable groups/nutrition	Health and nutrition monitoring Nutritional monitoring Monitoring zones and vulnerable groups Monitoring poverty factors
Food aid	Monitoring food-aid stocks Monitoring distribution Coordination of donor commitments

3.6.2 Food Security Related DSS

As stated earlier, DSS are designed to solve a specific problem in food production, distribution, utilization etc. However, DSS targeting agricultural issues or problems are more frequently used and prioritized.

DSS in the agricultural sector

Computer-based DSS have a long and well-established tradition. They can be effectively used in the agricultural production sector. Even from a business perspective, in 1998 it was found that "82% of farmers consider a computer based system to be a profitable investment (Nikkila 2007),

DSS in agriculture are designed to solve specific problems or help farm managers in making decisions. Hundreds of decision support models are developed world wide. Many attempts were also made to simulate the whole farm business and production of interrelated and complementary DSS which assist farmers through an integrated and holistic approach.

Wagner and Kuhlmann (1991) classified agricultural DSS into:

1. Planning models (produce or forecast future value of, for example, production and prices, or the SHALL-values);
2. Preparation/monitoring models (produce IS-data such as financial statements); and
3. Comparison models that include external, vertical, and horizontal comparisons of IS-and SHALL data.

Some models are designed to holistically assess the impact of changes in technology or policies on food, agriculture and use of natural resources. These models provide a quantitative means of assessing the consequences of policy and management decisions that affect sustainable food production to meet expanding future needs.

More specific and more integrated decision support systems such as a model for a farm, consists of four components:

- A Diagnostic expert-system for the identification of principle pests,
- A Control Expert-System for irrigation, fertilization, aeration etc,
- An information and extension package,
- A market presentation module.

DSS in agriculture are generally more specific and problem-oriented. According to Passam et. al, (2003), DSS in agriculture include: diagnosis of pests, diseases and nutritional disorders of agriculture crops; decisions on storage; distribution and marketing of produce; crop management in relation to climate condition; environmental consequences of agricultural actions; timing of crops.

An Example of a problem oriented DSS in agriculture is a DSS for the selection of a suitable variety of a crop. It is an important step and crucial in the production chain but availability of a large number of varieties with different characteristics makes the selection of the optimal variety for a given field difficult.

Table 2 shows a list of interrelated models. Each model or group of similar models has a specific role or information output to deliver. The models support each other to optimize the performance of the whole system (farm).

Table 2: An integrated decision support system

Model	What for
1. GISFARM	Geographical representation of data, particularly climate, but also results obtained including trade-off between different land uses (→5 means deliver data to no. model 5 or PROPLAN)
2. QUANSET	Determines expected quantities produced and availability of inputs and outputs to support decisions concerning production plans (→5, →7)
3. PRESET	Deliver expected market prices to support decisions concerning production plans (→5, →7)
4. PRETAC	Store the actual market prices of inputs and outputs (→6) and compare results with expectations
5. PROPLAN	Determine the optimal (non-dominated) production plan using expected prices and quantities (inputs and outputs) (→7)
6. COPRA	Store management system and production report to be compared with production plan of 7, (→9)
7. CASHPLAN	Financial plane to be compared with financial report, 8 and annual farm plan. Production plan to compare with production report of 6 (→9)
8. CONAC	Financial report to be compared with finance plan of 7 and annual farm report (→9)
9. USTAT	Compare data from different sources and horizontal comparison with other farms

Source: DSS Marienborn (Experimental farm), Kuhlmann F. 1999.

3.7 Data Needs

Another approach is the model development approach, in which the first step is to identify the envisaged output variables, i.e. what information should the DSS deliver. This requires answering previous questions on the purpose of modeling and simulation and the end users or target group.

If they are to be effective, policies aimed at promoting food security require accurate and timely information on the incidence, nature and causes of food insecurity and vulnerability (FAO 2000a, P. 3). Information needs to be tailored to answer key questions of decision takers and policy makers.

Table 3, below, provides a summary of the major food security indicators, and different stakeholders and influential actors (target group, data users or decision makers). It shows the food security indicators at the three important diminutions: availability, stability and access.

Table 3: Selected Food Security Indicators and Target Groups

Access	Stability	Availability	Target group
-Nutritional status -Micronutrients -Dietary habits -Copping strategies -Purchasing power	-Prices -Supplies -Imports -Exports -Storage -Processing	-Production levels -Availability of Inputs -Agro-meteorology -Harvest and losses -Farming methods	-Policy makers -Development partners -Business community -NGO's -Farmers' organizations -Technical services, -Media people -Consumers

Source: FAO (2000a)

3.8 Impediments and Determinants of using Food Security DSS

Political, institutional and business environment:
Despite the importance and usefulness of DSS, praxis shows that there is less use of DSS than expected. Several reasons are behind that including:

- A lack of political commitment due to competing demands for the allocation of scarce resources and underestimating value of information and knowledge-based decision making. Lack of political commitment undermines the importance of data, information, information-based decision making and consequently DSS.

- An absence of effective inter-sectoral and cross-ministerial connections, a failure to share knowledge (*information is power*), and a duplication of data collection and analysis efforts, all of which results in a poorer quality and quantity of information and data.
- That models and DSS are donor-oriented and not user-need and problem oriented.

Data and information related problems:

- A low reliability of available data. A good agricultural example of this is that published average yields and productions are "administrative" averages calculated for a wide range of production systems and not representative of food production).
- A poor coordination and collaboration with the information providers.
- A lack of resources to run certain data gathering surveys or studies etc.
- Poor organization in getting information from data sources (such as administrative records, studies and reports).
- A complex structure of information requirements.
- A lack of comparability of information and data.

Technical constraints:

- A full application of DSS requires considerable skills and training in several disciplines in order to manage, often complex, information systems.
- Collecting information and data is relatively difficult in Palestine due to the fact that the economic units are small and not well-organized.

Financial constraints:

- The question of money is very prominent in developing models as it is needed for such things as: collecting needed data, training users and convincing decision takers and policy makers to use DSS-outputs. It may take some time and effort to persuade policy makers and decision takers of the usefulness of DSS, since value added by introducing DSS is indirect and gradual.

The diseases and weaknesses of models include:

- Precise modeling (or simulation) is difficult because of the number of factors affecting a decision.
- Models are perhaps too individual. There is no common theoretical framework on design or use.
- Input data, particularly indigenous or built-in variables, are not always objective or real.

- Models built with rigid mathematical methodologies often need to be linked with subjective rules and evaluations, affecting the precision and accountability of results and consequently the decisions upon them.
- Some models require storing and processing large quantities of data.
- Some models are too academic, theoretical, complex, not user-friendly and less-applicable in praxis.
- User interfaces are often poorly designed and have great requirements.

To conclude this chapter, it is worth saying that decision support models and systems do provide increased efficiency both by decreasing expenses and increasing productivity. However, they require certain skills, knowledge, patience and dedication to successfully design, prepare and introduce the models into service. A trade-off is required between the tangible benefits of the DSS, model-building costs, data and other input needs and inefficiency.

4. Comparative Analysis of Selected Food Security-relevant DSS

Before comparing various DSS, it is worth clarifying essential practices and elements of DSS (Passam et. al. 2003).

1. Observation and measuring (observation on the real systems): The quality of the support from the systems depends on these observations,
2. Recognition of uncertainty in the system: the source of uncertainty in the system can be due to applying an inappropriate model, estimates and parameters (indigenous variables), the prior state of the system, the stochastic nature of processing within the system.
3. Management of the uncertainty: this, simply, is the process of converting observed values to model parameters (using, for example, filtering techniques, dynamic linear models, Bayesian networks and data-mining).
4. Decision support: this concerns algorithms for optimum levels, criteria for optimality, sensitivity of solutions to assumptions, as well as others. (An example of these is the Monte Carlo simulation models, LP, NLP, MOTAD, CP, MOLP and Safety-First Programming).
5. Model evaluation: the behavior of the model with the real life system.

From the model-outlay perspective, a typical DSS consists of three basic blocks: an input block, calculation block (data processing) and an output block. (Strauss, 2005, Figure 5.1, P43ff)

4.1 The Palestinian System for Environmental Resources Management PSERM[1]

PSERM is a micro-computer based system designed by the Applied Research Institute–Jerusalem (ARIJ) in 1996 for making projections and for analyzing the implications of alternative policy measures and development on the natural agricultural resources of Palestine.

The model works at governorate levels (J=1,…, m number of Governorates) which includes land, water, production costs, etc.

[1] The following sections, (4.1) are based on three documents: ARIJ, "PSERM: Final Report", Unpublished report"; ARIJ, "PSERM users manual; and a sources paper prepared by ARIJ specifically for this study.

PSERM is designed to estimate the best allocation of land and water resources to the different crops and cropping techniques (open farming, plastic houses, etc.) given limited land, available water, demand on that crop, and production costs (see text box 2).[2]

4.1.1 Data Inputs for PSERM

Data input includes (see model below and annex 1):

Location:
All governorates are included in the model. Built-in data (indigenous variables) is gathered, calculated and entered priori . The data can be edited by model users.

Land:
This refers to land available at the governorate level for agricultural production. Differences among soil types, soil fertility and soil related production variables are not considered.

Crop:
Available land and water is distributed among a given list of crops under one or different production techniques (see Table 4, below, and annex 2). Certain data entries can be edited or changed by model users, such as, cost items and productivity of different crops and production techniques.

Table 4: The various crops, (types of vegetables, field crops and fruit trees) included in PSERM

Fruit Trees		Field Crops	Vegetables	
Pomegranate	**Almond**	**Wheat**	**Parsley**	**Broad beans**
Quince	Apple	Barley	Peas	Cabbage
Vines	Apricot		Pepper	Carrot
	Avocado		Potato	Cauliflower
	Banana		Pumpkin	Corn
	Citrus		Radish	Cowpeas
	Date Palm		Snake cucumber	Cucumber
	Figs		Spinach	Eggplant
	Guava		Squash	Garlic
	Loquat		Sugar Beet	J.Mellows
	Olive		Thyme	Lettuce
	Peach		Tomato	Musk Melon
	Pear		Turnip	Okra
	Plum		Water melon	Onion
				Beans

2 Demand on a crop is measured as: (what is consumed by a population + exported - imported- production in rain-fed agriculture)

Population:
Population scenarios can be simulated for the current population. It was based on the year 1996 but a simulation can be conducted year by year from 1997 till year 2020. They are built on different natural growth rates and simulations of returnees. The Natural Growth Rate is measured for each year, a natural growth rate as follows:

1- LOW = 3.5%
2- MED = 4.0%
3- HIGH = 4.5%

Returnees:
The model accounts for two scenarios, one with no returnees and the other with returnees, as detailed below.

N= NO RETURNEES
R= THERE ARE RETURNEES

1- From 1996 until the year 2010, 200000 people are assumed to return home.
2- From 1996 until the year 2020, 250000 people are assumed to return home.

Economic conditions:
The model assumes either EG = ECONOMIC GROWTH, or ED = ECONOMIC DECLINE. If economic growth is assumed, one of five economic growth scenarios is selected, ranging from very low to very high. The model is optimistic in respect to economic growth.

LOW1= VERY LOW= 5%
LOW2= LOW= 10%
MED= MEDUIM= 20%
HIGH1= HIGH= 30%
HIGH2= VERY HIGH= 35%

Cropping patterns[3]:
PSERM covers four types of production techniques, namely: open farming, plastic houses, and plastic tunnels (low and high) for the different crops (see annex 2).

[3] Cropping pattern in PSERM refers to a farming system (or production process, which means: a crop + production techniques).

Yield:
This is the yield per unit area for the different cropping patterns. Yield is assumed constant for the governorate. It is important to recall that yield is the annual yield and not attached to months or production distribution. This means that price fluctuations are not considered, which could be the leverage for generating profit for some farmers.

Costs:
Included in the costs are all the materials, labor and marketing cost given per unit area for each cropping pattern. Production costs are used to calculate farm returns. It is important to keep in mind the significant difference in production costs according to, for instance, farm size, cropping date, intensity, fertilization strategy and productivity.

Box (2): Objective function and restrictions of PSERM

Maximize Profits=

$$\sum_i \sum_s \sum_l \sum_t P_{ijt}\, X_{ijslt} - \sum_i \sum_s \sum_l \sum_t C_{ijslt} * L_{ijslt} * X_{ijslt}$$

Subject to:

$$\sum_i \sum_s \sum_l \sum_t L_{ijslt} * X_{ijslt} \leq L_j^* A_j$$

$$\sum_i \sum_s \sum_l \sum_t W_{ijslt} * L_{ijslt} * X_{ijslt} \leq W_j^* A_j$$

$$\sum_i \sum_s \sum_l \sum_t W_{ijslt} * L_{ijslt} * X_{ijslt} \leq W_j^{**} A_j$$

$$\sum_s \sum_l \sum_t X_{ijslt} = C_{ij}^* + E_{ij} - M_{ij} - XR_{ij} A_{i,j}$$

Were:

I	Crops
J	District
S	Cropping pattern
L	Soil type
T	time
X	Output in tones per dunum of land
P	Price in JD per ton of crop
L	Land required in dunums per ton
C	Cost in JD per dunum of land
W	Water required in CM^3 per dunum
L*	Agric. Land available per region
W*	Lower water limit in CM^3 per region
W**	Upper water limit in CM^3 per region
C*	Consumption for region in tons
E	Exports for region in tons
M	Imports for region in tons
XR	Rain-fed production for region in tons

Market prices:
Monthly market prices for crops (not techniques) and not farm gate prices, but whole sale prices, which are most probably overestimated, and hence the farm returns are also overestimated. The annual average price is calculated from the mean of monthly prices and not weighted with the production distribution for each crop and cropping techniques, rendering the gross returns as noticeably different from the estimate.

Water:
Two scenarios for water availability at the governorate level are given: the lower bound and the upper bound.

Imports:
Imports are estimated per crop for the governorate.

Exports:
Exports are estimated per crop for the governorate.

Rain-fed production:
Production of rain-fed areas is estimated for each crop in the governorate.

4.1.2 Data gathered on each crop

1. Cultivated Areas
   The measurement unit of the data item is dunums (1 dunum = 0.1 hectares). To prepare PSERM, information on cropped areas was taken from statistical data, compiled by the various directorates of the Palestinian Ministry of Agriculture (MOA). The data was classified by district and cropping pattern for irrigated vegetables and field crops, since rain-fed field crops in Palestine are all planted during the fall. Rain-fed vegetables are mostly planted in the summer season, start planting in early March

2. Crop Yield
   The crop yield is measured in kilograms per dunum. The average yield of each crop was estimated based on field surveys and statistics collected by the various directorates of the Palestinian Ministry of Agriculture. Crop yield differences among the various types of cultivation were considered. Thus crop yield is different for plastic houses, rain-fed cultivation, open field irrigated cultivation and low and high plastic tunnels. Although crop yield tends to vary with soil and season variation in the same cultivation type, the numeration of these variations are difficult to obtain and were therefore omitted.

3. Crop Prices
   This is measured in Jordanian Dinars (JOD) for every kilogram of crops. The average currency exchange was based on 1995 rates: 1 JOD = 4.28 NIS. Information for crop prices was obtained from various sources, including, field surveys, statistics compiled by the Palestinian Central Bureau of Statistics and the Palestinian Ministry of Agriculture. The compiled prices represent the market price of each crop rather than farm-gate prices. Although farm-gate prices are better reflectors of farmers' income and net revenue, such information is not available. Monthly crop prices were included in the model as great variation exists in market prices between the seasons with and without crop production.

   Variation in the market prices of crops produced by the various cultivation types were unavailable, however, they were indirectly reflected in the monthly crop price sheets.

4. Water Requirements for Crops
   These are measured in cubic meters per dunum of crop. The values of 'crop water requirements' were calculated based on field data. CROPWAT software was used to generate the crop water requirement values of each crop. The values were different for each cropping pattern. In calculating water requirements, the following factors were taken into consideration:

   - Crop type – there were forty nine crops
   - Cultivation type – there was: open field irrigation, plastic houses, rain-fed crops and low and high plastic tunnels

   For rain-fed crops, the available water for the growth of these crops is actually limited by the levels of rainfall in the area. No supplementary irrigation is provided to rain-fed crops.

5. Cost of Production
   Cost of production for each crop, measured in Jordanian Dinar per dunum, was divided into four main categories: chemicals, raw materials, labor and 'other'. The category of chemicals includes fertilizers, pesticides, and herbicides. Raw materials include equipment, plastic sheets, irrigation network pipes, plastic houses and their depreciation rate and irrigation systems. Labor has been calculated according to human hours per activity. 'Other' includes farming processes (other than labor) such as plough, harvesting, seed sowing and other relevant activities.

6. Crop Consumption
   This is measured by tons per district. The estimate of crop consumption per district was generated data of the ‘food basket’, provided by the Palestinian Central Bureau of Statistics (PCBS). The total value (in NIS) of money spend by family unit on each crop was multiplied by the average household and divided by average crop price (NIS/ton) in each district. To obtain the total crop consumption in each district, the generated per capita crop consumption (in tons) was multiplied by population size.

4.1.3 Output Data

Output data of PSERM are:

- ✧ Gross Margin of each farming technique based on the given costs and estimated yield and market price. The model also calculates the aggregated gross margin for the optimal cropping pattern (solution), which is a rough estimate of net return for the whole governorate. Could be a good estimate of value added at the governorate level depending on the constituents of production cost.
- ✧ Cropping pattern at the governorate level or simply, the optimal distribution of available land and water to different crops and farming techniques (see annex 2) in order to cover unsatisfied expected consumption based on population, export, import and rain-fed production.
- ✧ Water allocation plan and water distribution among the different competing crops and farming techniques.
- ✧ Shadow prices of the limiting factors, particularly land and water, which is the value of marginal productivity of these resources at the governorate level.

4.1.4 Additional Notes

The model (PSERM) is to some extent synthetic, meaning that the parameters that used are either cross governorate estimates or are estimated by other studies.

One of the major weaknesses of the project is the fixed list of some important decision variables such as plant type (vegetables and fruits) and technology. It doesn't allow for introduction of new crops and/or new techniques.

PSERM is useful as a rough planning instrument for estimating crop production planning.

4.2 Policy Analysis Matrix (PAM)

The PAM framework developed by Monke and Pearson (1989) involves the derivation of several important indicators of 'protection and comparative advantage' (Fang and Beghin 2000, P13).

PAM is based on the fact that the production of any good or service, whether it is tradable or non-tradable[4], is the result of a transformation of some combination of traded and non-traded goods and services. Therefore the contents of a non-tradable good or service can be broken down into tradable and "original factors", mainly: labor, land, capital, and water (the essential domestic resources).

4.2.1 Objective

PAM is designed to deal specifically with measuring the impact of policy on the economics of production (FAO, 1991, P63). It provides information on two issues, protection and competitiveness. According to FAO, 2004, PAM provides a consistent framework to assess the impact of policy options on the comparative advantages of commodity chains[5].

4.2.2 Methodology

The basic information needed for compiling a PAM are, yields, input requirements and the market and social prices of inputs and outputs, world prices, free on Board (FOB), input shadow prices and import parity prices at the farm gate. (See table 5 below and Annex 3).

PAM is an accounting framework which separates the economics of a commodity system into its sources of private and social profitability (FAO, 1991: P63). PAM is an accounting framework not an economic model and does not contain behavioral relationships (FAO, 1992: P 152).

It is a product of two accounting systems. The first defines profit as the difference between revenues and costs (in private and social prices), while the second identifies effects of distortions (policy distortions and market failure).

Social price, (also called economic, efficiency and shadow price) of non-tradable goods or services is the domestic equilibrium price net of

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4 A product or input is tradable if it is importable or exportable, i.e. if its border price (PPP) is significantly different from international market price calculated at boarders,

5 For more information see: www.fao.org

distorting policy influences (minus subsidy plus fees). Social price of tradable, (output or input) is its trade parity price.

Table 5: Some input data to calculate social prices of inputs and outputs for a PAM exercise

Items to calculate social cost/price of each input and output
- ✧ border prices of (import or export), Cost-Insurance-Fright (CIF) & FOB
- ✧ transportation fees or costs
- ✧ shadow prices
- ✧ farm-gate price
- ✧ import price
- ✧ port handling cost
- ✧ import duty (transfer)
- ✧ export tax (transfer)
- ✧ subsidy (transfer)
- ✧ purchasing power parity price (PPP)

Production tables
- ✧ agricultural inputs (tradable and non-tradable)
- ✧ land
- ✧ labor
- ✧ equipment (capital)
- ✧ physical structures (water cisterns, plastic houses …etc)
- ✧ farm gate export/import parity prices
- ✧ yield (output)

Input disaggregating tables
- ✧ traded (fuel)
- ✧ non-traded factors (drivers)
- ✧ domestic resources (tradable and tradable components)

Source: see annex (3).

The calculation framework consists of several spread sheets as listed in Table 6, below. Private and social prices and benefits are calculated for each crop based on input/output relationships 'Sheet (1)', and calculated social prices of inputs and other cost items.

The result of the above *complex and tedious* calculations is shown below in a matrix, called Policy Analysis Matrix (PAM) in Table 7. The table shows a summary of the cost-benefit-transfers of each crop using private prices, the social prices and the transfers.

Table 6: Input and output data sheets of PAM analysis

Input data	
Sheet (1)	: Input/Output data per Dunum (physical coefficients)
Sheet (2)	: Export Parity Price of Tradable Outputs
Sheet (3)	: Import Parity Price of Tradable Outputs
Sheet (4)	: Private and Social Prices for Tradable Inputs
Sheet (5)	: Private and Social Cost of physical structures (assets)
Sheet (7)	: Private and Social Prices for farm equipments & Service
Sheets (8 & 9)	: Assumptions on Share of Tradable & Non-tradable parts
Sheet (10)	: Exchange Rates
Output	
Sheet (13)	: Protection and Efficiency Coefficients

Source: see annex (3).

Table 7: The policy analysis matrix

	Profit	**Cost of Domestic Resources**	**Cost of Tradable Inputs**	**Revenue**	
Net benefit	D	C	B	A	Private prices
Social benefit	H	G	F	E	Social prices
Int. effect	L	K	J	I	Transfers
	Net transfer	Factor transfer	Input transfer	Output transfer	

Source: FAO 1991, P 67.

4.2.3 Output and Deliverable Information

Based on the above table, few indicators or coefficients can be calculated, demonstrated in the following, table 8. Coefficients include the comparative advantage indicators (DRC, SCB) and the protection indicators (NPC, EPC).

Table 8: Protection & competitiveness coefficients based on PAM

Impact of policy on output prices	**A/E**	**NPC** Nominal Protection Coefficient
Compares value added measured in private and social terms. It is a more complete measure of policy impact since it captures the net effect of policies on both output and inputs.	**A-B / E-F**	**EPC** Effective Protection Coefficient
Compares the social cost of using domestic resources with the net value of foreign exchange generated. The DRC measures the overall efficiency of the commodity system.	**G / E-F**	**DRC** Domestic Resource cost Coefficient
Higher SCB indicates competitiveness of domestic product	**F+G / E**	**SCB**

Protection indicators

The NPC is the ratio that contrasts an observed (private) price with a comparable world (social) price. An NPC less than 1.0 indicates a negative protection or farmers could earn more if the market is liberated.

The EPC is a ratio of value added in private prices (A-B) to value added in world prices (E-F). If EPC is less than 1.0, it means a negative net protection over output and input.

Competitiveness indicators

The DRC measures a country's international comparative advantage in production. DRC is defined as the shadow value of non-tradable factor inputs used in an activity, per unit of tradable value added (G/E-F). The DRC indicates whether the use of domestic factors is socially profitable (DRC < 1.0) or not (DRC > 1.0). (Mohanty et. al. 2002:6)

A positive social profit indicates that the system uses scarce resources efficiently and a commodity has a static comparative advantage.

A good alternative for the DRC is the social cost-Benefit ratio (SCB), which accounts for all costs and avoids classification errors in the calculation of DRC (Masters and Winter-Nelson 1995). SCB is defined as (F+G)/E. higher values of SCB indicate stronger competitiveness. SCB highlights *Social Profitability*, which is_the difference between the social value of a product and its social cost. It represents the economic feasibility or national feasibility of the production line under review.

Table 9 below shows the results of a PAM application to rain-fed agriculture in the West bank late 1990s.

Most crops have a nominal protection coefficient around 1.0, or slightly less than 1.0, showing the little protection, if any. All crops have the same NPI, since they use the same inputs and most calculations rely heavily on assumptions.

It is similar for EPC, which shows a positive protection over field crops (wheat, barley and lentils). Tomatoes are the least protected, since inputs are imported and are competitive.

Table 9: Protection and Efficiency Coefficients of selected crops

DRC	EPC	NPI	NPC	Activity
Rain-fed Annual Crops				
0.94	0.89	0.94	0.90	Tomatoes
0.97	0.91	0.94	0.91	Squash
1.24	1.16	0.94	1.08	Wheat
1.43	1.16	0.94	1.08	Barley
1.41	1.12	0.94	1.08	Lentils
1.01	1.17	0.94	1.11	Chickpeas
Rain-fed Fruit Trees				
0.33	0.92	0.94	0.92	Grapes
0.64	0.93	0.94	0.93	Olives
0.66	0.93	0.94	0.93	Almonds

The table shows that in general, rain-fed fruit production is efficient in using domestic resources especially rain-fed fruit trees (DRC < 1.0), or in other words, a one dollar investment of domestic resources produces more than one dollar of foreign exchange (value added at social prices). Only field crops are not effective (DRC > 1.0), particularly wheat, barley and lentils. It is therefore worth importing such commodities from the international market (no comparative advantage).

4.2.4 Uses of PAM

The indicators, discussed above, show the competitiveness of the agricultural system, given current technologies, output values, input costs, and policy transfers. Benefits of PAM include the following:

- PAM can be used to construct scenarios comparing the economics of alternative pricing policies, technologies, or investments in commodity system (FAO, 1991:63).
- PAM is a useful way to identify sources of policy transfers and resource inefficiency (FAO 1991:63).
- PAM measures the impact of policy on prices and the efficiency in the use of resources.
- PAM answers questions such as: Do policies such as input subsidy or price support add to market distortions? And effect of externalities and monopoly which government intervention could correct? (FAO, 1992:134).
- PAM can be used to indirectly detect sources of distortions in the commodity system, particularly in relation to market and policy.
- PAM reveals the trade off between efficiency and other policy objectives, which help decision takers and policy makers in making informed decisions,
- PAM has been widely used in developing countries to measure efficiency or comparative advantage and guides policy reforms.

In summary, PAM can be used as a powerful tool by policy analysts to provide information in four different ways (FAO, 1992:151f):

1. To measure the level of price distortions and thus the efficiency and growth costs of government policy intervention.
2. To assess the efficiency in the effects of a range of policy tools.
3. To assess additional effects of policies so as to keep consistency between objectives and policies.
4. To compare the efficiency and growth potential of different farming, processing and marketing systems for a given commodity.

4.2.5 Difficulties of PAM

- PAM does not sufficiently consider yield and production cost per production unit. It is however difficult, since costs differ significantly within and across agro-climatic zones due to different technologies and techniques, different soil types, different varieties of the same crop and the production season.
- Differences arise at production, processing and marketing levels in the same country.

- Farms and firms are different sizes and have different scales of economy.
- There is a variability of price in all markets.
- The grade of crop that is likely to be exported or included in calculations need noting, as well as the proportion it makes up of the total produce. PAM is not corrected to the marketability and proportion of local production sold to foreign markets, it would be very subjective if it were.
- The prices produce can get depends quality, competitiveness and consumer behavior in international markets, which according to FAO, implies a need for price adjustment. (FAO, 1992:144),
- Data sets are determined by the purpose of using PAM analysis, whether to diagnose the effects of past policies, to predict the effects of current policies or to prescribe policy changes (FAO 1992:145). This is a further complication to data gathering and assuring reliable calculations.
- The comparative advantage changes dramatically according to the evolution of the world market for tradable outputs and inputs, through technical change within the production process or an increase in the price of domestic factors. It is important to keep in mind that PAM is a static method and sensitivity analysis is not easily applicable and does not overcome this limitation. (www.fao.org)
- The method of PAM does not take into account non-efficiency policy objectives, such as income distribution along the commodity chain and/or among different socio-economic groups involved in the production process.
- To improve its relevance, PAM should be combined with other approaches so that results obtained are complemented with a different knowledge. (www.fao.org)
- PAM is a type of Static System consultation model (see Passam et. al. 2003:729f fig.1-2), not an interactive or simulation model. This is another factor that limits its application.

4.2.6 Conclusions

- Adjusting the exchange rate for the impacts of output price distortions and macroeconomic policy effects is a complex task (Fang and Beghin 2000:16).
- Decomposing all input costs into their exact domestic factor and tradable input components, as required for PAM analysis, is a tedious task, which often only has a trivial effect on results (Monke and Pearson 1989; Fang and Beghin 2000:18).
- Although PAM can be used to assess issues of efficiency and transfer caused by endogenous distortions, such as market failures and

externalities, it is seldom used for this purpose. Its main application is in the analysis of the effects of government policy interventions, i.e. exogenous distortions (FAO, 1992:135).

- DRC may be biased against activities that rely heavily on domestic non-traded factors, i.e. land and some subsets of labour (Fang and Beghin 2000:14).
- World market prices change dramatically and differ significantly depending on factors including: quality, marketing strategies, country of origin and over time (seasonality) so that using a reference world price for agricultural commodity raises much more than quality differential problems.
- The prices which Palestinian products obtain in the world market are significantly less than average world market prices. Furthermore, not all products can be sold in the world market, only a proportion which indicates a need for surgical adjustments.

4.3 Cropping Pattern: software package (CROPPAT[6])

The allocation of scarce resources (water and land) to alternative enterprises (production possibilities) is one of the most important decisions in irrigated and rain-fed agriculture.

The selection of a cropping pattern at the farm level depends on several factors that include: production possibilities, resources base (water, cash and labor), location, farmers' interests and objectives such as risk aversion. Subjective information of farmers respecting market behavior is central to his decision making.

Since there are a number of alternative production possibilities, (cropping patterns or cropping portfolios), to choose the best option would require the evaluation of all the cropping options (activities or processes). Due to the complexity and uncertainty of factors affecting crop production, as stated above, decision making for selection of a suitable crop combination has become difficult.

According to (Amede and Delve, 2006) optimization modeling can be used to identify alternative production options to achieve food and nutrition security by changing crop combination.

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6 CROPPAT is a computer based decision support system developed by Abdul-hamid Musa as part of his PhD study in 1991.

4.3.1 CROPPAT objectives and uses

CROPPAT is designed to:

- Serve farmers, decision takers and policy makers as an agricultural data bank for vital agricultural data and information at a farm level in the different agricultural locations. The data bank includes all entered data (input-data), forecasts (processed data) and output data (results) etc.
- Assist farmers in forecasting future monthly prices of different crops whilst including their own expectations of future economic conditions.
- Calculate the expected risk to farmers in terms of variation in expected farm income.
- Assist farmers in finding the optimal cropping pattern which responds to: available production possibilities, farm resources constraints (land, monthly water available and monthly labor available), the objective of the farmer (i.e. profit, minimum risk or minimum capital investment), and expected market conditions.
- The trade-off table of the non-dominated optimal solutions produced by CROPPAT gives farmers a good idea of possible consequences to decisions, particularly cash flow, water requirements, farm income and expected risk, therefore enabling the farmer or an agent to make an informed compromise.
- When applicable, CROPPAT provides farmers, extension agents and agricultural planners a good sense of the opportunity costs (shadow and social prices) of the farm resources (water, labor, land, cash) on a monthly basis. This shows, for example, how valuable water is in September or May.

4.3.2 Methodology

CROPPAT Assumes that:

- Each farm has a different production course or possibilities (i=1,…n), that differ in things such as profitability, production requirements and profit stability.
- Each farm has access to a different resource base (fertile land, irrigation water, cash, labor) and they differ one month to another.
- Although production, prices, profitability and other variables differ frequently, on daily and weekly basis, it is possible to adopt a monthly changing basis.
- Farmers have different objective functions, either: profit maximization, capital cost minimization or risk minimization.

Production processes (i), among which scarce resources (land, water, labor and financial capital) to be allocated are defined according to:

- A crop with the possibility of having more than one process for the same crop if productivity, production distribution, profitability, resources use is significantly different, or if there are significant differences between varieties.
- Season including planting and harvesting dates as long as yield is significantly differences between different planting and harvesting periods,
- Technology; for example, open farming.
- Production techniques (i.e. fertilization strategy).
- Any other variable or factors which may affect the productivity or profitability, including soil types and land parcels.

These assumptions were mathematically formulated into: 'objective function', 'constraints' and so on, and are put together in the mathematical model of CROPPAT, as shown above in the equations in Box 3. In addition to the optimization algorithm, CROPPAT included a price forecasting module to predict monthly prices of potentially cultivable crops.

Box (3): CROPPAT's objective function and constraints

Objective function

Either, Maximize Farm Income (Gross Margin) $= \sum_{i}^{n} GM_i * X_i$, or

Minimize Income variability $= \sum_{i}^{n}\sum_{j}^{n} X_i * R_{ij} * X_j$, or

Minimize financial capital requirements $= \sum_{k}^{n} CF_k = \sum_{i}^{n}\sum_{k}^{m} CO_{ik} - CI_{ik}$

Were:

$GM_i = \sum_{i}^{n}\sum_{k}^{m} P_{ik} * Y_{ik}$ and

P_{ik} = forecasted monthly price = f(P_{ik-1}, P_{ik-2}, P_{ik-3}, EC1, EC2)

i,j = production line crop + technique + season, etc.

k = Months

P = Market price for crop I in month k

Y = Yield (kilogram per dunum) of crop I in month k

X_i, X_j = area allocated to process I or j,

R_{ij} = N*N Variance-covariance matrix of crops i,j

CF_k = Cash flow in month k,

CO_{ik} = Cash out-flow in process i and month k,

CI_{ik} = Cash in-flow form process i in month k

P_{ik-1}, P_{ik-2}, P_{ik-3} = Price last year, year before,...same month,

EC1, EC2 = Dummy variables represent economic conditions

Subject to the **constraints**:

Agricultural land availability ≤ farm size (in each month),
Land allocation constraint (Upper limits), if imposed by government,
Water availability constraint (per month for growing months k=1,…12),
Available labor per month for growing months k=1,…12 (if limited),
Minimum expected income (GM) for the minimization process

4.3.3 Data Inputs/Needs

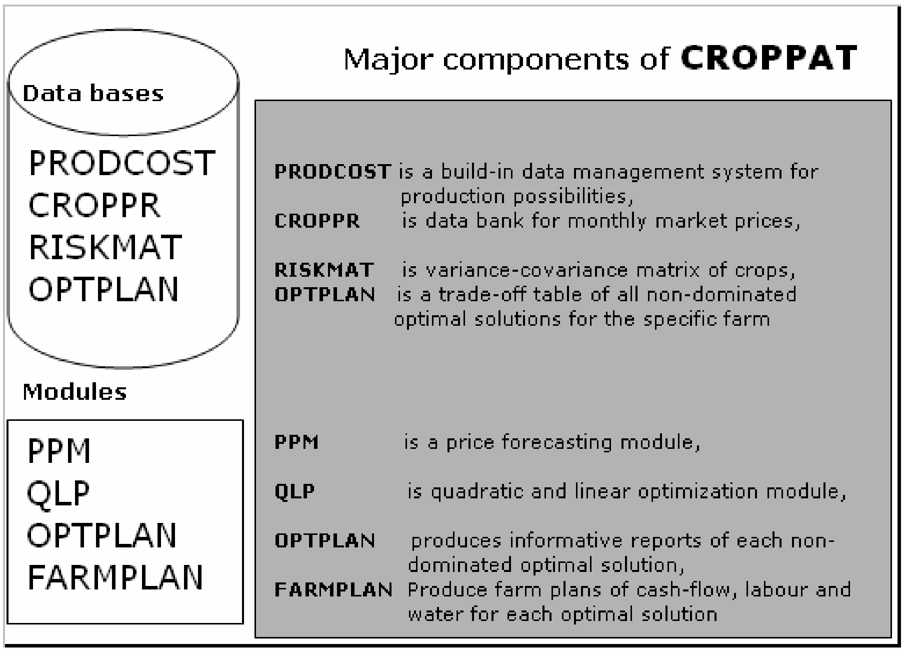
Annex 4 shows data needed to run the model. It is important to keep in mind that data can be imported from experimental farms, case studies, and other farms, among others.

In all cases, the data needs collecting directly from the farmers in the field. Data gathering to fulfill needs of the model is tedious and time consuming. It requires monthly data for the production possibilities.

4.3.4 CROPPAT Constituents

CROPPAT is developed by the author (Dr. Abdul-Hamid Musa) as a computer based Agricultural Decision Support System "software package". In addition to a user-friendly data entry and output system, screens, data management and help systems, the CROPPAT package contains the following major components (see Figure 2 below).

Figure (2): Major components of CROPPAT DSS



Source: CROPPAT, Users manual, 1991 (unpublished document).

Databases including:

1. *Market Prices data base*: is used to time series monthly prices of the different crops, regression coefficients of monthly prices with other regressive factors influencing market prices which are used to forecast monthly prices of crops under study. A market price data base is used to save forecasted market prices for future use in calculating returns and gross margin.
2. *Production Possibilities Data base*: Include Coefficients of the vegetable production functions and production possibilities.
3. *Variance Covariance Data Base:* Include coefficients of the farmers' non-systematic risk matrices based on the variance-covariance of market prices in summer and winter.
4. *Non-Dominated optimal solutions data base*: contains keys to identify farm, optimization conditions, forecasting scenarios, for example. The results of the optimization run in terms of cropping pattern or allocation of available land to competing production possibilities, production constraints, gross margin, capital investment requirements, expected risk and shadow prices.

Quantitative Analytical Routines (Modules): These include:

1. *Price Forecasting Modules* PPM: Two price forecasting modules are built-in to predict future monthly market prices of potentially produced crops based on multiple regression analysis of market prices and lagged prices, time, and economic conditions. The two forecasting models (Monthly Prices and Seasonal Prices) allow computing users' subjective perceived risk or uncertainty and market expectations. The modules forecast monthly market prices of crops according to their production possibility curves.
2. *Cost-benefit Analysis*: is a straight forward calculation of Gross Margin (GM) for the different production possibilities using farms' specific cost coefficient, production distribution, forecasted market prices etc. GM is used in the optimization process to maximize farm income, (aggregate GM or minimize risk –variance/covariance) given minimum expected farm income (GM). GM in this case is a constraint. Cost-Benefit Analysis is based on monthly data inputs to keep track of the cash-flow (in and out), since net monthly cash-flow is another objective (cash investment).
3. *Risk Optimization Module:* allows for linear and non-linear optimization (utility function). The former covers minimum cash investment and gross margin (profit) maximization, whilst the latter is used to minimize risk (variance-covariance of produced cropping portfolio).

4.3.5 Data Output (Deliverables)

- ✧ Non-dominated optimal solutions or cropping patterns satisfying the farmers' objective resource base (irrigation, water and farming area).
- ✧ A trade-off table containing non-dominated optimal solutions, i.e, optimizing at least one objective function under different production scenarios and production possibilities. [7]
- ✧ Production plans showing the farm budget of cash flow and water consumption.
- ✧ Shadow prices of the effective constraints on the monthly basis, i.e, water or land in specific month and not in general.
- ✧ Sensitivity of the different solutions and production plans to price changes and market behaviors,
- ✧ Model outputs are user-friendly and presented in a clear format, which increases the learnt effects of used computation, forecasting and optimization techniques.

Table 10: Selected data output of CROPPAT

Cropping pattern		Objective function (JOD)*			Shadow prices (JOD)		
Crop	**Area dunum**	**Gross Margin**	**Risk**	**Capital Invest.**	**Restriction**	**Month**	**Shadow Price**
Cucumber	13.7	21,009.7			Irr. Water	11	1.7
& Pepper	6.3	7,883.3			Land	5	1237.0
	20.0	28,893.0*	3503	5580			
Tomato,	3.0	1,850.0					
Paprika,	10.6	11,847.5					
& Pepper	5.1	6,302.5					
	18.6	20,000.0					
		1323*	4189	Expected Income			-31.4

Table 10 above shows a sample of various CROPPAT outputs based on real data. It shows the following:

- ✧ If the farmer seeks profit maximization (GM), he can get JOD 28,893 from allocating 13.7 dunums for cucumber production and 6.3 dunum for pepper. With this cropping pattern, the farmer needs to invest JOD

[7] For more information about Tradeoff see John Antle et. al. (May 2000), "Tradeoff Assessment as a Quantitative Approach to Agriculture/Environmental Policy Analysis", www.tradeoffs.montana.edu

5,580. The shadow prices column tells us that he can get JOD 1.7 per additional cubic meter of irrigation water in September (the shadow price of water in September), but the farmer can expect JOD 1,237 for additional land put cultivated in May, (shadow price of land in May).

- If the farmer is seeking risk minimization and requires only JOD 20,000, he can plant Tomato, Paprika and pepper. With this combination, the farmer's risk is only JOD 1,323 and he ought to invest JOD 4,189.
- If the farmer wants less income, the risk will drop by JOD 31.4, the shadow price of his expected income.
- It is important to recognize that the farmers more averse to risk tend to diversify production and cultivate traditional crops, (tomatoes rather than cucumbers for example) and will not use the whole farm area which is clearly an inefficient use of resources.

4.3.6 Other features of CROPPAT

- The model can be installed in a basic personal computer and is easy to operate.
- The user-interface was designed so that the user can run the system with minimal computer knowledge and skills. It takes the farmer through a easy step-by-step process to come up with a range of cropping patterns and plans best suited to his particular farming conditions. The final decision is left to the farmer as a trade-off between the different non-dominated optimal solutions and according to his preference and risk-attitude etc...
- The model can be used at a farm level and provides a consistent, satisfactory level of answers to farmers and researchers who need to choose cropping options.
- CROPPAT allows data imports from other sources including other farms, experimental farms and case studies. It also provides the user with information about modifications to suit the new farm.
- Farmers and others using the model can alter prices by changing their expectations of future markets or simply by editing the market prices data base.
- CROPPAT allows setting an induced cropping pattern as a production constraint (upper bound), and estimates the respective shadow prices for land at a specific month, showing the economic implications of such a governmental intervention.
- CROPPAT has a very important teaching and learning content for farmers, extension agents, agricultural students and others.

4.4 Food Insecurity and Vulnerability Information and Monitoring System (FIVIMS)

4.4.1 FIVIMS Defined

For the purpose of FIVIMS, *food insecurity* exists when people are undernourished as a result of an unavailability of food, a lack of social or economic access to adequate food, and/or where there is inefficient food utilization (FIVIMS, FAO 2000a:1). This definition reveals an interest in the symptoms and outcomes of food insecurity and vulnerability.

FIVIMS is an interagency initiative which promotes good practices in building information and mapping systems on food insecurity and vulnerability. It was founded in 1997 with the aim of improving the mobilization and utilization of information needed for decision making regarding food security for all (FAO, 2000).

Generally speaking, FIVIMS is any system or network of systems that assembles analysis and disseminates information about people who are food-insecure or at risk. Information includes who they are, where they are located and why they are food-insecure or vulnerable on national and global levels. (FAO FIVIMS Principles)

"A national FIVIMS is based on national and sub-national information systems related to food insecurity and vulnerability already in existence, responds to the information needs of the different user groups within country itself, and is operated and controlled by the country involved. It is country driven and user focused, designed in response to the needs of national decision-makers rather than imposed from outside."

4.4.2 Objectives

The immediate objectives of FIVIMS and similar Food insecurity information systems are (FAO FIVIMS Principles; FAO 2000a:4):

- To increase national and international attention to food security issues, so that they receive higher priority in policy formulation.
- To improve the reliability, quality, quantity and timeliness of national and sub-national food security-related data and analysis.
- To facilitate multi-sectoral analyses, through better integration of complementary information components.
- To promote better use of information, through better understanding of users' needs and more effective dissemination.
- To improve users' access to information, through networking and sharing.

- ✧ To assist targeting those people and areas suffering most from hunger and malnutrition.
- ✧ To help in identifying causes and take remedial action to improve the food situation.

4.4.3 FIVIMS Core Principles

Eight principles underlie the present approach to strengthening and consolidating national FIVIMS. They can be summarized as follows:

- ✧ To recognize that needs differ across countries.
- ✧ To identify and respond to users' information needs.
- ✧ To build on existing information systems and avoid/reduce duplication.
- ✧ To practice incremental implementation methods.
- ✧ To integrate household-level analysis and gender-disaggregated information into national and sub-national policy-making.
- ✧ To promote institutional sustainability.
- ✧ To promote cost-effectiveness.
- ✧ To make appropriate use of new technologies.

4.4.4 Data Needs

For establishing a food insecurity and vulnerability baseline or information system indicators from different surveys should be included. (See table 11). Topics may include: population, macro-economy, socio-economic, health, nutrition and agriculture (FAO 2005:25).

The following table (FAO2005:26f) shows a list of information categories and data required on national and sub-national levels to establish a national FIVIMS.

Table 11: example of data needs for a national FIVIMS

Data Required on a Sub-national level	Data Required on a national level	Category of Information
✧ Household characteristics (size, structure, dependency ration, fertility rates ✧ Prevalent livelihood systems (by incidence, age and gender)	✧ Population (numbers, growth rate, social groupings, etc.) ✧ GNP ✧ Macro-economy structure and trends ✧ Natural resources ✧ Agriculture sector (structure, production and farming systems) ✧ Employment	Background information

Data Required on a Sub-national level	Data Required on a national level	Category of Information
✧ Production by farming systems (levels, trends etc) ✧ Food markets (food market dependency etc) ✧ Food consumption (composition of diet and food use practices/expenditure) ✧ Access to information and extension.	✧ Production (level/trends by commodity) ✧ Trade (imports/exports by commodity, food prices ✧ Food aid ✧ Food consumption (food intake levels and expenditure on food) ✧ Food security relevant policies and strategies	Food Economy
✧ Maternity and child health ✧ Access to Water/sanitation and hygiene ✧ Care practices	✧ Maternity and child health ✧ Access to Water/sanitation and hygiene ✧ Care practices	Nutrition and Health
✧ Prevalence and depth of under-nutrition (Food intake and deficiencies), ✧ Production (level and instability) ✧ Food consumption and practices ✧ Food production ✧ Livestock production ✧ Rainfall level and variability ✧ Carrying capacity of land ✧ Conditions of natural resources base ✧ Incidence and severity of drought ✧ Incidence and severity of pests ✧ Food self-sufficiency ✧ Food storage ✧ Purchasing power (income and prices) ✧ Access to productive assets (land and credit etc) ✧ Household asset structure ✧ Ownership of livestock ✧ Market behavior	✧ Prevalence and depth of under-nutrition (Food intake and deficiencies) ✧ Nutritional status of mother and child ✧ Production (level and instability) ✧ Food stocks ✧ Food imports dependency ✧ Purchasing power (income and prices)	Food and Nutrition Early-Warning

Source: FAO2005, P26f

4.4.5 Chronology

Existing national information systems to FIVIMS include the following general examples (FAO 2000a:5f):

- ***Agriculture information systems***: Often operated by the MOA and cover different topics such as agricultural production patterns and performance, agriculture trade, agriculture inputs, farming systems and rural income levels.
- ***Health information systems***: include data on nutrition indicators.
- ***Land, water and climatic information systems***: provide information on topics that include: topography, landform, land use and cover, water availability and use, land suitability and productivity and land tenure.
- ***Early warning systems***: monitor agricultural production indicators (rainfall, vegetation, crop production, market prices etc.) during the cropping season to produce timely domestic food supply and demand projections, which helps prepare people to cope with a situation of shock (see also FEWS 2005).
- ***Household food security and nutrition information systems:*** Data may include food production and stock levels, food prices, source of livelihood and indicators of health and nutrition. It requires extensive primary and secondary data collection networks.
- ***Market information systems:*** designed to enhance market transparency by providing information on agricultural inputs, commodity prices and marketing opportunities,
- ***Vulnerability assessment and mapping systems:*** Produce reports to describe and analyze the risks vulnerable population groups are exposed to.

Other systems introduced by FAO consolidate the seven sub-systems above down to four systems. FSIEWS (Food Security Information and Early Warning System) encompasses four systems that emphasize the importance of production and market information (FAO 2000:18):

- Agriculture production monitoring (APM)
- Market information system (MIS)
- Monitoring Vulnerable groups (MVG)
- Food and nutrition Surveillance system (FNSS)

In praxis and on the national levels, FIVIMS related information systems are tailored according to a country's needs, economic-resources base, available data base, national food security strategy and other factors (as stated in the principles above). Some examples of NIS relevant to FIVIMS follow below (FAO 2000a, PP 7-10):

- ***SNAP (Mozambique)***: caries out agronomic monitoring and field surveys, agro-meteorological and satellite information. SNAP generates food supply and demand balance sheets,

- ✧ ***CASPAR (Senegal)***: monitors agricultural production, rainfall, pests and diseases, area under cultivation, production estimates, cereal prices and other market information.
- ✧ ***FHANIS (Zambia):*** collects general food security information at household levels (including: food availability, stocks, prices, trade and market).
- ✧ ***SISVAN (Peru):*** collects information for country food and nutrition profiles, indicators on nutritional status, health etc.
- ✧ ***FIVIMS related IS (Viet Nam):*** includes at least 4 information systems of relevance to FIVIMS: a crop monitoring system CMS and market information system MIS run by MOA; Nutrition Surveys conducted by National Institute of Nutrition; and household income and expenditure surveys produced by the CBS.

4.4.6 FIVIMS Related Products in OPT

In the occupied Palestinian Territories, the Joint FAO/WFP Comprehensive Food Security and Vulnerability Assessment (CFSVA March 2007), which followed up on the *Comprehensive Food Security Assessment* conducted by FAO with WFP in 2003, concluded that most surveys to identify food availability, access to food and nutritional problems are *ad hoc* and carried out by various parties often using different procedures, methods and approaches which does not allow comparability (FAO2008:5). A structured or semi-structured national FIVIMS in the occupied Palestinian Territories (OPT) was perceived by FAO as difficult to establish since some required information systems (components) are not comparable, not compatible and/or even not in place.

FIVIMS in the OPT focused on strengthening and building capacity of the technical staff in the line ministries and agencies in order to provide sustainability to the food security information system (FAO 2008:4)[8]. Its impact mainly consists in the development of:

i. A food security monitoring module to measure household food acquisition and the (proxy) food consumption gap (food deprivation). In this respect it provided a new set of food insecurity estimates at a household level and a comprehensive analysis of contextual factors and trends (FAO 2008:10).
ii. A review of social protection programs (FAO 2008:19f).

[8] FAO (2008), "Management of a Food Insecurity and Vulnerability Information and Mapping System: Phase 2West Bank and Gaza Strip", Project OSRO/GAZ/501/EC, Final Report (Draft), Unpublished.

A **Socio-Economic and Food Security (SEFSec)** is currently in the pipeline. SEFS MS would make available data on the following: (FAO2008:28)

- ✧ Income/expenditure patterns, including food expenditure and consumption.
- ✧ Mitigation and coping strategies.
- ✧ Socio economic characteristics for households profiling and clustering.
- ✧ Social safety nets and their regularity, dependability and predictability, (including assistance by type, value and source).
- ✧ Resilience and vulnerabilities.

These information outputs are expected to provide critical inputs to operate the policy matrix below:

Table 12: Food policy areas and selected food economy indictors

Own production	In-kind received food	Purchase of food, including on credit	Household Food acquisition modality
- Food production - Food processing	- Formal food aid - informal social safety nets - Other income transfers	- Cash income - Income transfers - Food marketing	Policy area

4.4.7 Conclusion

- ✧ FIVIMS, GIEWS and other related systems provide a good platform from which informed decisions can be made about strategies for reducing food insecurity.
- ✧ Without doubt, NISs vary widely from country to country especially in terms of the indicators and analytical techniques they use and their institutionalizations and institutional sustainability.
- ✧ Livelihood Analysis Approach is used in some of these systems (models). The Famine Early Warning System (FEWS) is one such example. It allows linking changes in these monitoring data to food security outcomes. The importance of such linking from a Decision-maker's perspective lies in answering the following questions: Which population groups are likely to be food insecure and why? What are the best ways to mitigate the effects of shocks? What available response would be most appropriate to address the problem?

- "National FIVIMS … calls for bringing together data sets and information systems such as agriculture, health, land, water and climate, early warning, household food security and nutrition, markets, disaster management and mapping systems." (FAO 2005:10). A FIVIMS compliant country needs to have these components (sub-systems) in place.
- FAO in the Occupied Palestinian Territories (OPT) stresses the absence of a socio-economic or food security monitoring system operating in West Bank and Gaza Strip (FAO 2008:28) and argue that "food insecurity depends on overall household consumption poverty. Access to food is affected by income poverty." (FAO 2008:27)

5. Conclusions & Suggestions

The study raised three questions which are tackled in the following sections:

- ✧ Does Palestine need DSS?
- ✧ Which DSS are needed?
- ✧ What are the DSS for?

5.1 Conclusions

Background

- ✧ Food insecurity is a multi-dimensional and complex problem that has risen over a long period of ineffective and inefficient use of resources. Food security policies aiming to reverse the situation are expected to take a long time but serious articulation on real information respect needs, assets, resources, experience, and competence ….etc.
- ✧ The problem of insufficient resources to obtain adequate food is only one of many barriers facing families coping with food insecurity and vulnerability. The attempts of family members to make thoughtful food decisions are crucial to their food security, especially in terms of: allocation, mobilization and utilization of available resources, particularly of natural resources.
- ✧ It is worth highlighting that "food insecurity persists largely because of governance and policy failure at the national level. If food insecurity is to be eradicated, political well, national and international – is very essential.
- ✧ There is a comparative advantage of agricultural production in Palestine primarily arising from the cost effective off-season production of vegetables and also some fruits. Data gathering should stress the importance of seasonality and perhaps, in the monthly discrepancies particularly in production (production distribution), resource use and prices. This would help to identify strengths of Palestinian agricultural production, possible interventions and give much needed support to decision takers at the farm level, as well as to policy makers.
- ✧ It is widely known that farmers and policy makers rely less on information when taking or making decisions.
- ✧ Market information is lacking, despite the fact that data is available at lower cost and requires potentially less efforts.

Purpose

- Important principles for creating food security related information systems in general and FIVIMS specifically, include: the recognition of differences across countries, particularly their needs, problems and resources base; to respond to users' information needs; and to practice incremental implementation methods.
- FIVIMS and related systems are designed to provide Decision makers and other users with policy indicators concerning food insecurity. PAM is a data (policy) analysis framework or tool, while PSERM and CROPPAT are decision support models (systems).
- PSERM is a useful tool for planners at governorate levels. It helps depict gaps between the optimal and actual allocation of land and water resources at governorate levels.
- CROPPAT is a useful tool to help farmers/researchers/extension agents and decision supporters as it helps in sound and efficient allocation of farm resources and in planning production at field levels.
- PAM gives a rough estimate of the comparative advantage and potential competitiveness to particular agricultural production, processing and marketing at a commodity level. It is most useful in assessing policy and market failures.

Decision Unit Comparison

- Analysis in CROPPAT is based on a well identified cropping process, not merely vegetable name. While in PAM and to a less extent in PSERM it is centered on the vegetable (product).
- CROPPAT considers seasonality, monthly price fluctuations and production distribution, while PAM and PSERM are more static frameworks that depend on annual averages.
- PAM and to a lesser extent PSERM are linked to the market, (they are more market oriented). CROPPAT deals with farm data and hence, is largely farm-oriented.
- Decision support systems and simulation models can help identify the gaps (in productivity for example), evaluation of the impacts and most important they lie a basis for a long term usage of such service,
- Gap analysis would greatly help in resource allocation and in improving relevance, efficiency, effectiveness and sustainability of assistance and investments

5.2 Recommendations

Institutionalization

- It is important to start with simple models with higher added-value (information). In other words, to start from where others started and not from where they finished.
- There is a crucial need for a platform that eases processing and exchanges of information. The suggested platform would facilitate flow of information, coordination and collaboration among stakeholders and would help ensure the effective participation of farmers or end-data-users.

Appreciation of information

- Assess information use and impediments to the efficient utilization of available information at the different levels in order to help future orientation of capacity building efforts and allocation of national resources.
- Raise awareness of decision takers and policy makers of the tactical and strategic importance of using information and information processing (DSS) in making, assessing, refining and correcting their decisions.
- Launch programs to strengthen the national capacity to produce information on food insecurity and vulnerability which encourages best practice, especially at the farming and household levels, since they are the principal producers of farm data.
- Design and run programs to strengthen the national capacity to produce information at community and governorate levels that responds to the needs of decision making.
- Build the capacity of civil society activists and governmental organizations in information based decision making, use of decision support systems and mainstreaming information in decision making.

Further Research and Studies

- Greater efforts should be allocated to research in areas that have a high chance of increasing productivity, (a high value added from information) such as the case in the Jordan valley and the rain-fed highlands.
- Data gathering and decision support should be geared towards promoting agricultural local production driven (supply), not demand driven.
- Carry out a preliminary assessment of using quantitative methods and decision support systems at the different levels and venues and analyze its implications.

- Assess the quantitative analysis needs for applying the National Food Security Strategy.
- Establish a Market Information System, useful at farm and policy levels. Data available at the PCBS and other data sources may be a strong start if efforts are consolidated.
- Establish a well structured Farm Management Information System as part of a broader Agricultural Production Information System in collaboration between the PCBS and MOA. This would benefit to: understanding of the production system, designing interventions, analyzing the impact of policies and above all, it would support decision makers of all levels. A Farm Management Information System is the corner stone for any national agricultural or agriculture related information system.
- Study efficiency of water use in the different production sites under the different production processes and for the major seasons.
- Establish and run a useful agricultural market information system, or at least a data base. Data available at the PCBS may be a good starting point.
- Carry out periodic gap or comparative analysis (IS-SHALL) for agricultural productivity and profitability in the different agro-climatic zones and for different farming systems, crops, techniques, etc.
- Carry out gap analysis between water use and efficiency, land productivity and efficiency under the different economic and political scenarios.
- The national food security strategy needs updating and plans to provide a framework for the formulation and implementation of food security interventions at governorate and community levels need developing.

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Annexes

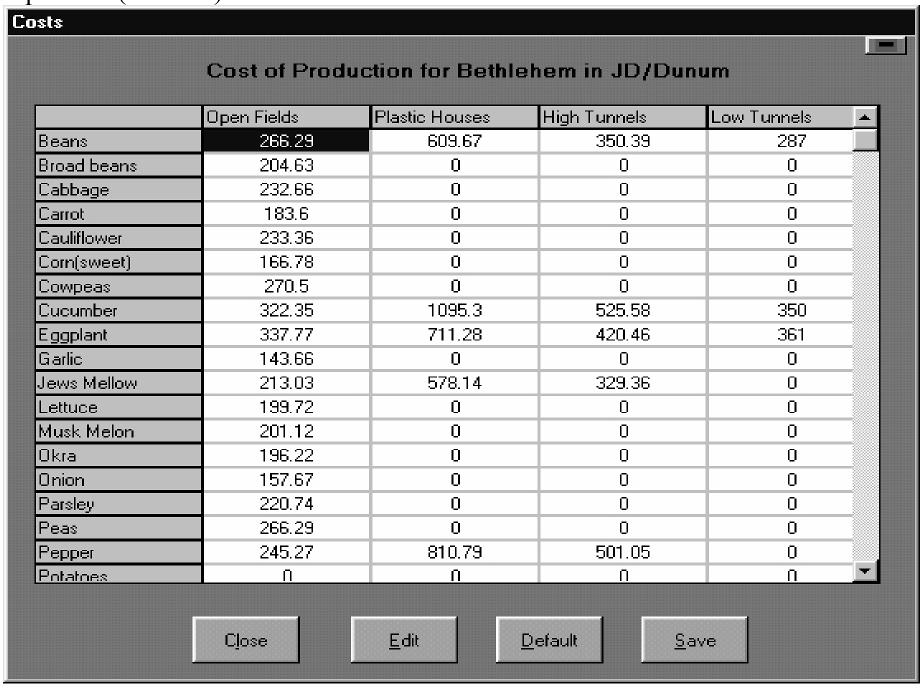
Annex (1): Data Input, Scenarios and Source for PSERM

Data input

Source of data	Scenarios	Variable
MOA	1 (no soil type...etc.)	Land
PCBS	3 Scenarios - Low growth rate (3.5%), - Moderate (4%), - High (4.5%)	Population
	2 Scenarios - No returnees, - Returnees 200-250 (000 PA)	Returnees
	5 Scenarios - Very low (5% PA), - Low (10%), - Moderate (20%), - High (30%), and - Very high (35%)	Economic conditions
	7 Scenarios - Irrigated, - Rain-fed, - Open - Plastic tunnels (Low), - Plastic tunnels (high), - Plastic houses - Season?	Cropping pattern Better (farming system)
Field and MOA	- 1 Scenario	Yield
Calculated based on field survey and MOA	- Calculated	Production cost (and marketing)
PCBS (Wholesale price)	- Gathered	Market prices (monthly)
	2 Scenarios - Lower bound, - Upper bound,	Water
	Governorates	Location
	Calculated	Imports
	Calculated	Exports
	Calculated	Gross revenues
Data output (Determined)		
Gross margin		
Optimal cropping pattern		
Water requirements		
Shadow prices of limited resources		

Annex (2): Data Input and Output Screens of PSERM

Input data (PSERM)



Costs

Cost of Production for Bethlehem in JD/Dunum

	Open Fields	Plastic Houses	High Tunnels	Low Tunnels
Beans	266.29	609.67	350.39	287
Broad beans	204.63	0	0	0
Cabbage	232.66	0	0	0
Carrot	183.6	0	0	0
Cauliflower	233.36	0	0	0
Corn(sweet)	166.78	0	0	0
Cowpeas	270.5	0	0	0
Cucumber	322.35	1095.3	525.58	350
Eggplant	337.77	711.28	420.46	361
Garlic	143.66	0	0	0
Jews Mellow	213.03	578.14	329.36	0
Lettuce	199.72	0	0	0
Musk Melon	201.12	0	0	0
Okra	196.22	0	0	0
Onion	157.67	0	0	0
Parsley	220.74	0	0	0
Peas	266.29	0	0	0
Pepper	245.27	810.79	501.05	0
Potatoes	0	0	0	0

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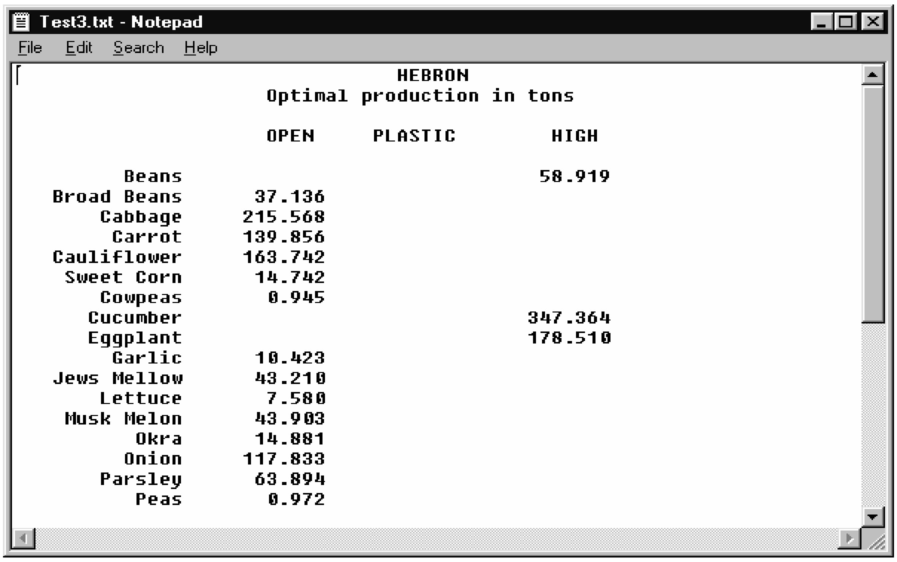
Output data (PSERM)



Test3.txt - Notepad

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HEBRON

Optimal production in tons

	OPEN	PLASTIC	HIGH
Beans			58.919
Broad Beans	37.136		
Cabbage	215.568		
Carrot	139.856		
Cauliflower	163.742		
Sweet Corn	14.742		
Cowpeas	0.945		
Cucumber			347.364
Eggplant			178.510
Garlic	10.423		
Jews Mellow	43.210		
Lettuce	7.580		
Musk Melon	43.903		
Okra	14.881		
Onion	117.833		
Parsley	63.894		
Peas	0.972		

Annex (3): Data sheets for PAM analysis

Table (1): Input/Out Data per Dunum (du)		**Table (2): Export Parity Price of Tradable Outputs**	**Table (3) : Import Parity Price of Tradable Outputs**
I.	**Output Items:**	Exchange Rate	Exchange Rate
	Main Product	FOB Border Price	FOB Europe
	By-Product	Quality Factor	Insurance and Freight
	Total Output	FOB Border Price	CIF (Port)
II.	**Cost Items:**	Handling and Clearance Charges	Handling and Clearance
A.	<u>*Variable Costs*</u>	Transport from Packaging to Border	Port Fees @ 3%
1	Seed/Seedling	Price at Exporter Packaging Center	Taxes @ 4%
2	Mulch	Marketing Costs	Value Added Tax @ 17% (VAT)
3	Fertilizers	Certificate of Origin	Landed Price
	- Manure	Transport, Wholesale to Packaging	Transport to Warehouses
	- N.P.K.	Post Harvest Labor	Wholesaler Markup
	- Ammonium sulfate	Post Harvest Materials	Price at Warehouses
	- Super phosphate	Price of Produce at Wholesale Market	Transport to West Bank/Gaza
	- Potassium nitrate	Transport Farm to Wholesale	Retailer Markup
	- Micro-Nutrients	Price at Farm-gate	Retailer Price
4	Chemicals	Price at Farm-gate	Price at Farmgate
	- Pesticides	Adjusted Price at Farm-gate	Adjusted Price at Farmgate
	- Herbicides		
	- Fungicides		
	- Others		
5	Irr. 'Water		
6	Tractor Service		
7	Hired Labor		
	Total Variable Costs		
B.	<u>*Fixed Costs*</u>		
1	Depreciation		
2	Interest		
3	Land		
III	**Profit Account**		
	Gross Margin		
	Net Profit		
	Return to Water		

Continue Annex (3): Data Sheets for Policy Analysis Matrix (PAM) Analysis

Table 4 : Private and Social Prices for Tradable Inputs	Table 5 : Private and Social Cost of Water Wells	Table 7 : Private and Social Prices for farm equipment (tractor) Service
Exchange Rate	**A : Fixed Cost:**	**A : Fixed Cost**
FOB Europe	Well depth	Exchange Rate
Insurance and Freight	Cost of drilling & casing / m	FOB Europe
CIF Ashdoud	Cost of drilling and casing	Insurance and Freight
Handling and Clearance	Use life of the well	CIF Ashdoud
Port Fees @ 3%	Hours of use per year	CIF Ashdoud
Taxes @ 4%	Interest rate	Port Fees @ 3%
Value Added Tax @ 17% (VAT)	Depreciation of well	Taxes @ 4%
Landed Price	Capital cost of well	Total Landed Cost
Transport to Warehouses	Cost of vertical pump	Transport to Warehouse
Wholesaler Markup	Cost of engine	Markup @ 10%
Price at Warehouses	Cost of pump and engine	VAT @ 17%
Transport to West Bank/Gaza	Use life of pump and engine	Price at Warehouse
Retailer Markup	Salvage value @ 20%	Transport to Farm
Retailer Price	Initial capital cost	Total Price on Farm
Price at Farmgate	Depreciation	Salvage Value @ 20%
Adjusted Price at Farmgate	Capital cost	Initial Capital Cost
Proportion	Sub-total of all fixed costs	Userlife
	B : Variable Cost:	Rate of Interest
	Engine power	Hours of Use per Year
	Fuel consumption	Depreciation
	Fuel price	Interest on Capital
	Cost of fuel	Sub-total Cost
	Maintenance	**B : Variable Cost**
	Sub-total of variable costs	Maintenance
	C : Total Cost per Hour	Maintenance
	Grand Total Cost per Hour	Fuel
	D : Total Cost per CM	Tractor Driver
	Capacity of the Well	Sub-total Cost
	Cost of pumping one Cubic Meter	**C : Total Cost**
	Adjusted Cost of pumping 1 cm	Grand Total Cost
	Proportion	Adjusted Grand Total Cost
		Proportion

Continue Annex (3): Data sheets for PAM analysis

Table 8& 9 : Assumptions on Share of Tradable & Non-tradable of Enterprise Budget Elements	**Table 10 : Exchange Rates**
Revenue Account:	Official Exchange Rate (OER)
Cost Account:	Shadow Exchange Rate (SER)
Variable Costs	Social Conversion Factor (for TR)
Fixed Costs	
Natural Resource Cost	
Farm equipments	
Farm infrastructure	

Table 13 : Summary of Protection and Efficiency Coefficients

Activity	NPC	NPI	EPC	DRC
Rain-fed Annual Crops				
Tomatoes	0.90	0.94	0.89	0.94
Squash	0.91	0.94	0.91	0.97
Wheat	1.08	0.94	1.16	1.24
Barley	1.08	0.94	1.16	1.43
Lentils	1.08	0.94	1.12	1.41
Chickpeas	1.11	0.94	1.17	1.01
Rain-fed Fruit Trees				
Grapes	0.92	0.94	0.92	0.33
Olives	0.93	0.94	0.93	0.64
Almonds	0.93	0.94	0.93	0.66

Annex (4): Data Needs and Data Output of CROPPAT

Source	Defined	Farm data
Automatic		Farm code
User	Dunum for crops	Available Area
User	$ per dunum	Land rent
User	Dunum for spec. crop	Upper limit
User	Cubic meter per month	Available Water
User	$ per cubic meter	Water cost
	Working hours per month	Available Labour
	$ per working hour	Labour cost
Market information to forecast prices and calculate risk		
Build-in for all crops	Variance-covariance of crops σ_{ij} (I,j = crop = 1….n)	Risk Summer Risk Winter
User	%	Prob. Of econ. Boom
User	%	Prob. Of econ. Worsening
Forecasted	Monthly prices for crops	Market price
		Production process (data)
Automatic		Process Code
User	Crop	Vegetable crop
User	Open farming or others	Production technique
User	Month	Planting date
User	Month	Harvesting date
User	Jan. – Dec.	Month
User	Cubic meter per month	Irrigation water
User	Working hours per month	Labour (prod'n)
User	per month	Material cost
User	Harvest (kg) per month	Production kg
User	Working hours per month	Labour (harvest)
User	Transportation + fees+..	Marketing cost
Calculated		Labour (Total)
Calculated		Cost (Total)
Optimal Solution (output data)		
Area per crop		Area allocation (solution)
Gross Margin		Expected income
Total cash-in needed for crops		Capital investment
Total variance of returns for above solution		Risk (income variance)
Value of limiting factors / unit		Shadow price
Capital invested per month		Cash flow plan
Water requirement per crop		Water use plan