Information and Communication Technologies (ICT) for Agricultural Extension – An Overtime Israeli Perspective

E. Gelb, B. Gal, D. Wolfson

Table of Contents

Abstract

The collaborative contribution of Extension and Research to Israel's agricultural productivity and profitability is hails back to the late 19th century. It facilitated technological innovation in agriculture, transfer of information, training of farmers and sector connectivity. These were in effect a dictate of continuously deteriorating agricultural terms of trade, crippling water shortages and severe climate and soil constraints. Perspectives and insights gained in the process have stood the test of time. Adoption of ICT for Extension is a unique and illuminating example.

The Israeli Extension Service's (IES) strategic decision to adopt Information and Communication Technologies (ICT) significantly enhanced Extension's capabilities and scope of activities. ICT empowered extension's ability to develop, introduce and adopt innovative agricultural technologies and collaborate with research and international partners. Adoption of ICT as one instance of technological innovation dramatically improved the transfer and management of information, production chain efficiencies and integration within and with the agricultural sector. These were and are critical Israeli Extension success factors enabling Research, Services and Farmers ability to sustain a profitable, thriving agriculture sector. This success is a major contribution to rural viability and a model for adoption of technological innovation.

Keywords: Agricultural Extension, technological innovation, ICT

Background – Israel

Israel's population is currently (2009) 7.6 million with a total arable area of 440 000 Ha. With water scarce only 182,000 Ha. are irrigated - to a large extent with recycled water. Israel's topography spans areas from 1200 m. above to 400 meters below sea level within a small, compact geographical confine. This results in an extremely wide range of variable climatic and soil conditions in close physical proximity.

Israel's geographical location is characterized by a moderate climate which is translated to a comparative advantage in supplying out of season agricultural products to Europe, the Americas and Asia. Sustaining Israel's comparative advantage depends on product quality, innovativeness, technological excellence and optimized use of scarce water, labor and land resources within Israel's multi varied environments.

Together with research, extension and stakeholder involvement a continuous variety of "agricultural products" is available. The product categories include food, raw materials, agricultural inputs, leisure products, primary and secondary services, resource management technologies and derived products of education, science and culture. Inevitably the products are export-oriented, with high-value quality items for specialized, sophisticated and increasingly demanding niche markets. They in turn are now supporting Israel's agricultural sector viability. All these are served and in many cases dependant on ICT supported Extension activities continuously undergoing ICT supported specialization within the Extension service. The specialization requires an ever growing emphasis on innovation, professional competence and intimate association with R&D, stakeholders and international collaborators.

Israel suffers from chronic water scarcity, with a short rainy season and frequent droughts. Examples of alleviating measures include a wide range of water conservation procedures, water recycling installations, sea water desalinization, innovative agricultural water conservation technologies, implementation of hi-tech irrigation methods and equipment, genetic engineering of plants for salt tolerance - to name just a few. All these are at the forefront of innovative ICT developments and ICT supported systems. Israel's ICT Supported Water and Irrigation Technology alternatives provide a useful model of the impact of Extension's ICT initiatives and their implementation. These, again in turn dictate a relentless pace of technological innovation and its implementation. Failure to keep pace with innovation has dire consequences for farmers individually and for the agricultural sector in general. A major measure of extension excellence in this context is minimizing the time lag between innovation availability and its profitable adoption. Adoption of ICT by Extension detailed below is an example of the importance of Extensions' involvement in technological innovation by minimizing technology adoption time lags.

Lehman and Regev (2008) review in detail the particulars of Israeli Agriculture and list areas of technological innovation priorities, efforts and excellence. They include water technology, genetics, environment management, and ICT. Success of these efforts is described in Table 1 which quantifies Israel's agriculture relative productivity since 1986. This accomplishment follows the results of the increase in food production dictated by the establishment of the State of Israel in 1948. This achievement was facilitated at the time by a dramatic increase in research and extension facilities. Eventually the outcome by 1962 was a surplus of agricultural production. The export of the high value agricultural produce component was then expected to balance the cost of importing agricultural products which were still

lacking: food-grains, oilseeds and sugar. Export of agricultural products (2008) exceeds $2.13 Billion which is about 25% of the total agricultural production which in turn contributes 1.7% of the GDP and 3.5% of total Israeli exports. About 65 thousand workers are employed in the agricultural sector representing less than 2% of the Israeli workforce

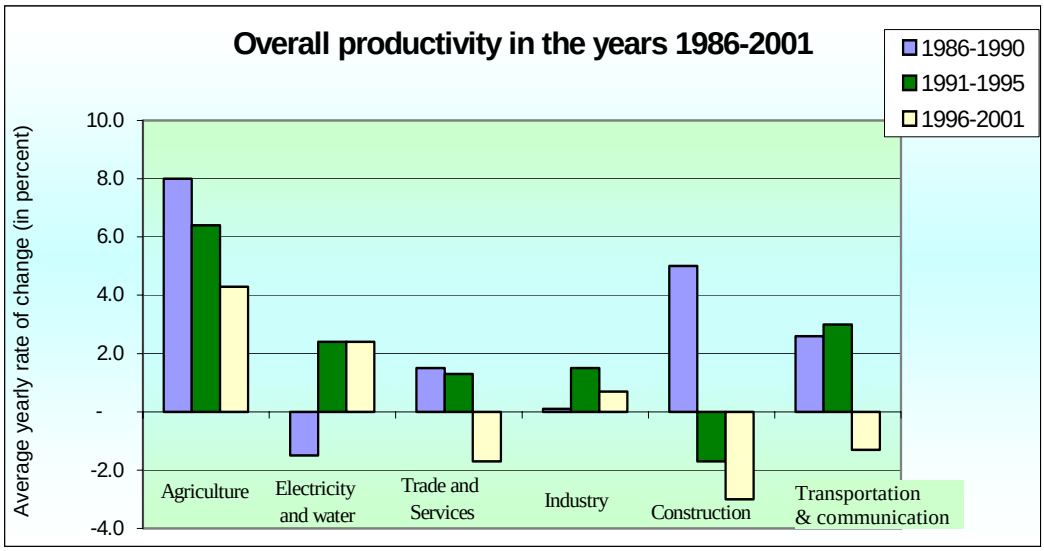


Table 1. Relative productivity of Israel's agriculture (Gelb, Levanon, 2008).

The Israeli agricultural productivity is to large extent the product of collaboration between the Israeli scientific, educational, agricultural and rural sector's innovation environment. It includes

- Universities, colleges, regional research centers and agricultural vocational schools;
- Sophisticated technical, communication, regulatory and commercial ICT infrastructures and services;
- Intimate connectivity with all stakeholders and their organizations in Israel and abroad;
- Efficient and varied transportation facilities and other services;
- International collaborations.

Israel's Extension Service (IES)

The IES is a semi independent unit within the Israeli Ministry of Agriculture and Rural Development. The short and long term IES goals are derived from national agricultural and rural policies. They include for example replacement of labor by capital, water use efficiency, the prevention of groundwater pollution, increased exports, environmental concerns, sustainable rural viability and more. The 2009-2010 IES goals are focused on continued replacement of labor with capital, more efficient use of water, adoption of innovative best practices to peripheral areas, an emphasis on promoting the export of the agricultural sector's products, environmental conservation, ever improving product quality and product diversification. All this within improvement of internal IES efficiency

The basic IES organizational structure concurs with the Ministry framework of regional offices supported by the various Ministry departments at the Beit Dagan headquarters located near Tel Aviv. Beit Dagan also hosts the headquarters of the

national Agricultural Research Organization. The ministry's site www.moag.gov.il outlines and details the current organizational framework of the Ministry, the IES and the Agricultural Information environment in which it operates.

The following is a short history of the IES - condensed with special thanks to our colleague Y. Elkana, 2001.

"…Israel has a long history of agricultural extension. It began in fact with the establishment in the 1880s of the first modern agricultural villages, and was provided by agronomists of the first agricultural school (established in 1870) and of the settlement bodies. At the start of the 20th Century, researchers of newly established research farms (later developed into stations) also provided extension. At the termination of the Ottoman Empire control and the taking over by Britain, the Jewish Agency Settlement Department established an extension unit that operated from the research stations. In parallel, the British Mandate Government set up a Ministry with professional departments that among their responsibilities, was the provision of extension.

Following the establishment of the State of Israel in 1948, the various professional departments of the newly established Ministry of Agriculture began providing, systematically organized extension to all agricultural producers.

In parallel, the Settlement Department of the Jewish Agency greatly strengthened its pre-statehood extension department into a full-blown extension service that provided extension to the tens of thousands of new immigrants who were settled in new agricultural villages. They needed very basic type of extension services: how to plow, seed, cultivate, and how to feed and milk a cow. This parallel system recruited from established villages hundreds of young farmers who would serve as village level instructors, living in the village among their farmers. Each village of 60-100 farm families would receive three of these para-professionals: a) Social -- to teach how to organize and manage a democratic village cooperative and run it both socially and economically; b) Home economics and management, working with the women of the household; and c) Agricultural - a generalist, to teach and follow very closely all the agricultural operations of each farmer. The latter received professional backing from regionally based Subject Matter Specialists of the Agency, mostly ex-Kibbutz branch managers and agricultural high school graduates.

In 1960 the specialists of these two systems were united under one overall umbrella to form the "Unified Extension Authority" (UEA), with 12 regional centers. In 1965 the Ministry of Agriculture adopted the Agency Subject Matter Specialists and formed one national service -- "The Extension and Professional Service" the IES of today. This organizational effort included the Soil and Irrigation Field Service with its 14 laboratories. It was a large unit established to enhance water use efficiency.

The model for IES was based on the USDA Extension service with an input of experience from the Netherlands providing a professional, specialized service to reach all the farmers through regional centers.

A variety of extension methods and communication media were developed with a strong emphasis on personal on-farm visits. Strong ties with research were established from the start including involvement of extension specialists in R&D. Over time farmers, through their local, regional and national organizations were associated as part time and eventually full time partners in planning of Extension

steered by a National Extension Assembly, chaired by the Minister of Agriculture. Farmer representatives formed the majority in the council.

During this period Israel's agriculture underwent extreme changes - from an almost traditional sector to a highly sophisticated one, at the forefront of technology. IES underwent a process of increased specialization, devoting more of its time to generation of technology through applied R&D activities at farm and research levels. They included new concepts such as fertilizer use incorporated in irrigation, biological and integrated pest control and multi disciplinary orientation. In the duration many of the IES became involved in international programs with their derived expertise. Demand for more specialized extension went hand in hand with increased farmer proficiency. The extension competence included individual specialization, innovative and unique technologies, niche market considerations including the risk taking involved.

IES led collaboration between research bodies, growers, their organizations, service providers and client consideration were major contributors sustaining the viability of the Israeli agricultural sector. Regardless governmental funding constraints and political dictates resulted in drastic staff reductions – from 1980 the ARO was reduced from 1800 to 800 individuals and IES from 640 to about 150 today (2008). The inevitable need to update equipment, facilities and capabilities augmented this situation forcing both the ARO and the IES to seek additional sources of funding, partnership and commercialization. Partners included growers' associations, production and marketing boards, agricultural committees, regional councils, regional enterprises, packing houses, food processing industries, seed companies, fertilizer and chemical producers and agencies, irrigation equipment industries, machinery firms, and more – in Israel and abroad……"

The IES has a long and successful record of promoting technological innovation in agriculture, in many cases being the facilitator of technology transfer from research to the field and providing feed back to research - Katz, Ben David (1975). It is almost impossible to exaggerate the importance of ICT in maintaining these results - enabling smooth interactions between innovation developers, End-users, the various beneficiaries, the public at large and international collaborators. In fact in times collaboration between Extension and research is so close as to make differentiation most difficult. Gelb, Kislev (1982) detail another example where farmer participation in deciding and funding the research priorities enabled a “bottom up” contribution to the traditional “top down” public funding allocation framework. Participants are more varied and include the research personnel (which in some cases can be the farmers or other beneficiaries), the Institutes funding or contracting the studies, those involved in the funding allocation process, end-users and the public at large. ICT is at the forefront of these interactions - facilitating real time access to information in addition to accelerating the rate of knowledge and innovation transmission – all these with Extension leading the way. Furthermore ICT currently enables ongoing, real time, public accessibility to available information. This concept identifies demands and expectations from publicly funded research benefiting them with real time response ability to general feedback, comments, questions and suggestions from the public.

The Israeli extension officer is invariably a specialist with a large degree of individual "academic freedom". The officer's professional environment includes subject matter committees, other subject matter specialists e.g. at Extension headquarters and farmers – some with equal and even superior training. Ever since the IES was

established there have been additional providers of extension including several with pioneering efforts in ICT Adoption. These extension entities have in the past, and are currently closely associated with IES. They include:

- Regional councils and cooperatives organized as local government and municipal entities. These farmer-led entities have also developed a range of economic services for their members such as packing houses, cotton gins and feed mills, increasingly maintain professional field staff to organize, guide, and coordinate agricultural activities in their jurisdiction. All these in turn provide regular extension;
- Regional R&D entities that maintain extension directly with "model farms" and pilot programs – interacting directly with end users;
- Agricultural-input company specialists dealing with e.g. seeds, animal feed, pesticides and herbicides, pharmaceuticals, fertilizers, irrigation equipment, greenhouses, nurseries, etc;
- Agricultural produce processing agro-industries;
- Private consultants.

Financing of IES in the past had evolved and adapted over time from a straightforward government funding model based on the recognition that extension is a "public good". The following lists some of the past supplementary sources of funds for extension in general and specifically for ICT.

- Farmer "taxation": All agricultural production is regulated via Agricultural Production Boards that levy annually 0.625% of the value added of their produce. Of this sum 90% goes to Agricultural R&D (via joint farmer and research committees) and 10% to extension activities. This participation is a long standing agreement;
- Funding by national and regional growers' associations for standard extension services and /or specific equipment – e.g. laptops and/or mobile phones for Extension field staff;
- Funding by national and regional growers' associations for enhanced extension services in a "contractual 24/7 extension commitment";
- Funding by farmer "commodity services" e.g. packing houses, feed mills, etc;
- Partnerships with farmers such as the Irrigation and Soils Field Service which is funded by users through municipal taxes paid to regional councils and by direct payment for laboratory tests;
- Direct Farmer payment per extension visit over and above "standard services";
- Direct Farmer payment to extension personnel on a private basis after their official working schedules;
- Direct payment to IES and/or individuals for participation in related activities by rural regional and/or agricultural schools, participation in various campaigns e.g. environmental conservation activities, programs by other Ministries, entities, etc;
- Funds generated by collaboration with and participation in International ICT Adoption programs – e.g. via EFITA/AFITA (European/Asian Federation for Information Technology in Agriculture).

This multi sourcing of funding provided IES with ongoing flexibility which in turn enabled IES to access the latest technological innovations. In the case of ICT IES was always able to access the latest ICT – hardware, software and methodology - even if

only for demonstration and evaluation. This head start was and is in the common interest of farmers, service and equipment providers, research and IES. A unique advantage of these partnerships and options was IES ability to "leap frog" convention to cutting edge ICT innovations and avoid a counterproductive and cumbersome linear progress. ICT supported trailblazers for example initiated irrigation methodology to integrate fertilization and plant protection measures in water applications, innovative genetic adaptations, innovative automation, modeling which enabled subject matter integration, connectivity and more.

The Israeli Extension Service and ICT

By the early 1980s a need for a more formal evaluation of the nature and impact of ICT in and on extension was recognized, in Israel as well as in other countries. The Florida Cooperative Extension Service (1983) for example initiated a series of conferences evaluating Technological Change – specifically focused on Computers in Agricultural Extension Programs. Others were to follow, worldwide. Although no longer a novelty ICT Adoption for Agriculture and Rural Development still remains a contiunuously studied critical issue at regional, national and international levels. Gelb et al (1975 – 2008) follow this evaluation processes in some detail. Ongoing evaluation efforts are supported via a multitude of ongoing specialized and/or combined studies, fairs, workshops and conferences. A recent example is the 2008 IAALD/AFITA/WCCA conference - see http://iaald-afita-wcca2008.org. Appendix A summarizes its recommendations relevant to ICT Adoption and extension.

The 1983 Florida effort was followed by a bi-national US – Israel workshop see Gelb, Schmidt and Rauschkolb (1985). The workshop focused on the role of ICT for extension in general via each country's specific experience. The Israeli emphasis was on the 1979 Israeli Extension Service (IES) "Computer Supported Extension" (CSE) effort. It was defined as *"… a major effort to integrate advanced quantitative methodology into the extension supported decision-making process – from policy making to field recommendation levels…"*. The extension organizational outline, physical and information environments at the time (1985) are presented in Appendix B replicating the original presentations. The following details several aspects of CSE:

The CSE supported categories were:

- data and information - input and management;
- Extension service programs – statistics, Decision Support Systems, graphics, communications;
- agricultural production automation and process control;
- production planning, monitoring and evaluation;
- crop and production models and simulation;
- optimization;
- expert systems.

The basic guidelines for CSE implementation were:

- adopt CSE gradually at all IES levels without structural changes;
- computer facilities will be accessed, shared and not duplicated;
- in-service ICT training will be provided;
- incorporate ICT in every possible extension activity;
- ensure maximum CSE flexibility.

- CSS will be incorporated into existing collaboration with farmers, research and services.

Some major issues, constraints and insights emerged early on during CSE implementation and were reported and discussed in the workshop. They included:

- the ability of management to guide regional activities and support them;
- funding procedures and funds for equipment procurement;
- lack of tools for evaluation of improved extension staff effectiveness;
- guidelines for allocation of extension priorities;
- over-enthusiasm and unrealistic expectations;
- benefits inherent in openness and collaboration;
- a need for retraining, education and reassessment of programs and their goals;
- how not to stifle initiatives, unplanned but successful scenarios and insights;
- how to cope with restructuring within the organization's balanced hierarchies, management and individual conservatism and in-service inadequacies;
- how to define and meet personal, political and organizational expectations.

The interim CSE results were reviewed during the workshop discussions. The criteria for the review included:

- improved service to the farmer including information delivery efficiency;
- a better farmer understanding of production and biological systems;
- improved professional communications – between extension and farmers, both with themselves, with each other and with research;
- additional dimensions to extension activities which included remote sensing and control, real time imaging, simulation, signaling of priorities to the private sector and integration with the education systems;
- a basis for professional development of programs and IES personnel

The lessons and notes of caution from CSE implementation that were reported emphasized the following:

- employ ICT to foster the closest collaboration with research, producers and their organizations;
- ensure maximum extension program flexibility;
- focus ICT efforts to optimize scarce human capital and funds;
- verify the primacy of the human element in all programs.
- be sure to consider farmer's interests;
- there are conflicting interests in CSE implementation which include non convergent policies;
- knowledge is power;
- market forces and interests can conflict with farmer's concerns and extension recommendations.

A question which was discussed in the workshop but left open for further joint and individual deliberation was who should pay for this ICT derived public-good benefit - as a case study of ICT Adoption for extension. A specifically useful and focused evaluation regarding the various aspects and constraints of ICT Adoption for extension was derived from an EU sponsored workshop in 1997. This workshop analyzed in close detail the initial adoption and use of Internet for Extension Gelb, Bonati (1997).

ICT supported and embedded systems in Israeli agriculture illustrate the role of extension and research in ICT development and its' Adoption. Characteristically they also open a promising venue for research to measure the rate of ICT Adoption and its benefit. In detail Gelb and Kislev (1982) quantify farmer (adopters) preferences for technological change via their financing of agricultural research and extension. Gelb, E., Levanon, D., (2008) elaborate these interactions in Israel in detail over time. To go into further ICT Adoption detail Gelb, et al (1975) outline farmer recognition of the benefit of a dedicated computerized predictive plant protection model and its economic benefit - the Benefit Cost Ratio (BCR) was 4.5. Gelb et al. (1996) elaborate by measuring the specific economic value of information as manifested in ICT. The unique information measured was milk yields and estrous collated in a dairy milk parlor Decision Support System (DSS). The initial benefit was found to be close to $70 cow/lactation with a system repayment period of three years. This measured ICT benefit was over and above the contribution to improved dairy management derived from adopting a computerized Dairy Management Information System (MIS).

Table 2 presents three examples of the impact and results of the IES involvement in innovative ICT development and adoption. The programs were shared by research, extension and end users. Appendix C and D elaborate. Table 2 details the three. In each one IES was involved in the four stages of initiation, system development, pilot evaluation and widespread adoption of the result. The three examples reflect a regional collaborative effort, a collaborative effort to develop a tailored Management Information System (MIS) and an innovative plant protection model

Product Name	**Type**	**Management Methodology**	Funding source	Net Benefit
Afimilk	Management Information System (MIS)	Exception and deviation	Farmers	US$200.00 cow/lactation
Phytek	MIS	Rates of deviation change	Farmers and Private	>10% irrigation efficiency
Wheat Disease Control Advisor	Expert System	Disease control decision rules and recommendations	Farmers and Public	$92.70/Ha

Table 2 Examples of ICT products and their funding ((Gelb, Levanon, 2008).

ICT adoption by the Israeli Extension service combined and combines substantial home work, local and international collaboration, trial and error. All these dictate the need to maintain IES comparative advantage as an agent of change, an effective "middle man, honest broker" positioned between new, old, useful or irrelevant innovations and their uptake. This responsibility is constantly being tested under the confines of ever decreasing public funding and resulting staff reductions see Fig 1. In addition there was and still prevails the ever growing influence of the powerful sentiment that ICT development and Adoption should be left to the invisible hand of the market. Prahalad (2004).

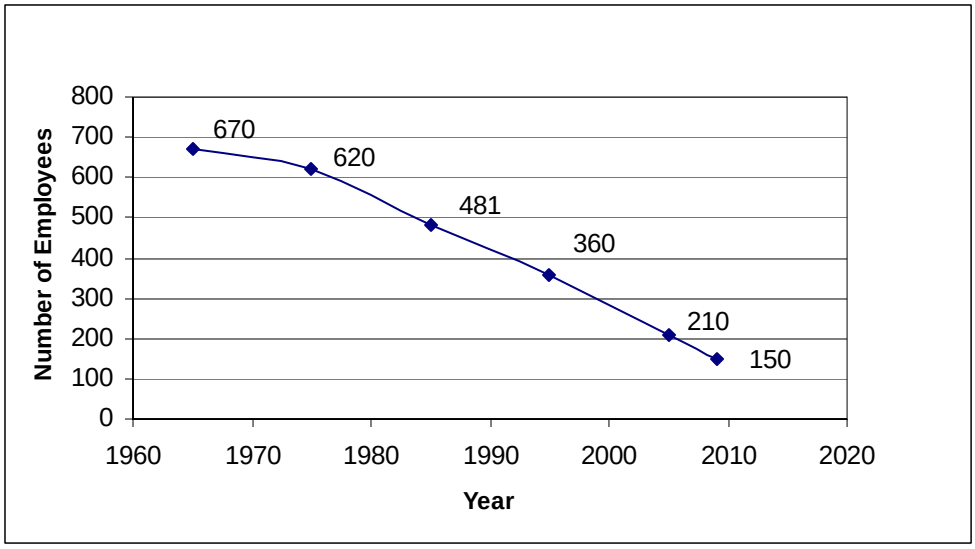


Fig. 1 Israeli Extension staff members (Wolfson, personal correspondence)

A unique IES feature of ICT Adoption since 1983 was the establishment of an informal, internal interest group to evaluate and promote ICT issues. The issues included familiarization with ICT innovations, their relevance for agricultural research, management and production, adoption of current and innovative ICT, identification of knowledge gaps and the nitty-gritty of equipment and ICT training specifics. Understanding the contribution of ICT to extension methodology and effectiveness, including the impact of innovative communication options, were of decisive significance in the forum discussions. The insights are discussed in detail below. The composition of the group involved a subject matter specialist from each professional department. The assumption at the time was that it would be more effective to ICT train an agricultural subject matter specialist than attempt attaining agricultural subject matter competence by an ICT specialist.

This interest group proved to be an invaluable forum. It provided an ongoing source of experience, personal support, utilization of experience, insights and invaluable contacts when and as needed. Its composition ensured the sharing of ICT Adoption commonalities between the various agricultural crops, extension methodology and activities, ICT development, innovation uptake and evaluation of the whole range of ICT problem-solution results including trials and errors. These critical forum contributions minimized the occurrence of repeated mistakes. Consequently the benefit from Extensions' "scarce" human capital was optimized. The forum identified and focused on the major ICT development and adoption problems while benefiting from organizational memory and hands on experience. In practical terms, by 1995, the annual interest group summary agenda included: discussion and evaluation of diversification to laptops; collaboration with software programmers as part of collaboration with research and farmer organizations; defining collaboration with local knowledge bases initiatives; ICT supported extension delivery routine – including Farmer ICT basic training; initial evaluation of site specific Crop Management, GIS, GPS, e-Marketing, two crop models, two ICT managed irrigation and fertigation systems, greenhouse management systems, process control pilots, distance learning; international collaboration priorities and internal in service ICT training. (Source: The 1995 Interest Group summary agenda). The 1995 cutting edge technology agenda at the time is a far cry from the current ICT reality and ICT needs in Israel today. Essentially ICT proficiency, connectivity and digital inclusion are non

issues in the sense that ICT is a commodity. In practical terms Extension does not have to teach farmers how to use ICT supported applications and systems. IES can now focus on ICT initiatives and activities which are a reply to the question: "now that you have ICT proficiency, systems and applications how do you ensure your benefit from their uptake?".

The above CSE overview provides a useful baseline yardstick for understanding past and current IES ICT Adoption. It should be used in evaluating the initiation, planning, goals and implementation issues discussed below *with a strict proviso and note of caution – these background notes are neither recommendations nor recipes for successful ICT Adoption for extension They are not intended to, and do not, provide recommendations or suggested preferences for a comparable course of action or policy priorities. These are left to the reader's discretion and have to be decided and timed based on local specifics, experience and expectations.*

The perspectives and insights gained are in turn a useful case study of the Adoption of Technological Innovation

Case Studies and Issues

With the above background in mind the following will attempt to highlight the issues that confronted the IES. This will be done by the following:

1. A review of IES a. e-mail and b. Internet adoption;
2. Detailed comments from discussions with Extension subject matter specialists;
3. An outline and comments on current issues confronting the ongoing adoption of innovative ICT.

1. a. Adoption of e-mail.

IES officers are spread throughout Israel – see Appendix B 1. The basic framework is of regional Extension representative offices with local agents and specialized subject matter departments in the national headquarters – currently in Beit Dagan, near Tel Aviv. These serve the regional officers and provide professional backup when and where needed. This routine in turn depends heavily on efficient, real time if possible, communications.

The concept of a unified and comprehensive communication environment was conceived many years before the various ICT became available. This concept was compatible with IES's comparative advantage as a technological innovator and an agent of change. These characteristics are unique for a government office and indeed IES was among the Israeli government pioneers.

An attempt to harness the IES to local networks (e.g. regional telephone facilities) proved unsatisfactory. The availability of the academic BITNET model at the time and the advent of Internet for public use were promptly utilized and adopted by IES individuals. This initiative preceded the decision to provide personal computers for extension officers. The goal was to provide maximum real time computerized connectivity to at first all extension officers and eventually to extension clients. Initially IES management decided to utilize these communication facilities within the service based on the early activities of the pioneering extension officers (a classical "bottom-up" initiative). The purpose was to facilitate communication between the extension officers, the regional offices and IES headquarters, headquarters, regional offices and the extension field officers and the regional offices between themselves. Shortly afterwards the network was opened to others – clients, service providers, collaborators and associates – in Israel and abroad. In the 1990s the service communication equipment was based on land lines, dial up modems and stationary

computers in the various IES offices. The officers did not have communication facilities, mainly modems, at home. At this point the main investment in equipment was in dial up modems and establishing a pilot program. As mentioned IES was among the first governmental units to revert to electronic communications prior to development and adoption of the current universal government e-mail network. A typical resulting bureaucratic dilemma was "should the government buy dial up modems for Extension staff so they could work from e.g. home?"

The Floriculture and Production Economics departments were selected to evaluate e-mail communications, language constraints and program effectiveness. Till then the departments relied on surface mail which comprised flyers, seasonal recommendations, invitations to field demonstrations and interest group meetings. These were held routinely 2-3 times each month for the Extension officers and several times annually for farmers. It was realized early on that e-mail, in order to succeed, would have to replace "snail mail". A prerequisite for this cut off was absolute e-mail reliability. Accordingly Extension officers were trained to attain that goal. Preparations included meticulous training of personnel, installing personal modems, purchasing personal computers and standardizing a communication program with e-mail facilities. With all that accomplished the system was tested to be sure it worked. It should be noted that all this was done based on the Israeli land line services using Windows 3.0. The Internet vendor at the time used a bi-lingual – English-Hebrew version of an e-mail program, Cameleon, which was compatible with Windows 3.1 as well.

The human element adjustment of the ICT transformation proved to be challenging. The main problem was internalizing the superior connectivity, derived routines and information exchange methodology. One obstacle derived from the fact that the Floriculture department target group consisted mainly of professionals uninitiated in ICTs and their utilization. Training had to include basic ICT familiarization and technical proficiency to facilitate the initiation and operation of the pilot program. Most of the participants internalized the new work patterns while realizing that without participation they will be "out of the know". This proved to be a powerful incentive – sufficient for overcoming the introductory problems and enabling the success of the pilot. Most of the older Extension officers mastered e-mail reading although e-mail writing remained an impediment for years to come. Typing was not a common skill at the time.

The format of both e-mail routine and methodology adoption was initially top down dictated. The sequence was to ensure reading electronically transmitted material to be followed by between-officer communication. It was expected that most of the content would be focused on problems encountered during visits to the fields. The communication format was assumed to be a description of a problem and a request for an opinion and/or a recommendation. This concept was to include eventually pictures in addition to written communications. Over time this differentiation was trivialized with the wide spread availability and use of the cameras embedded in mobile phones, dedicated cameras and the availability of advanced Internet capabilities. This e-mail picture relay option became standard and a common communication tool between the Extension officers and their clients. The phones however did not replace the more sophisticated visual aids necessary to communicate and share more accurate details of specific problems such as disease details, nutrient deficiencies, etc.

By 1995 personal laptops were added to the Extension officer's toolbox – again a pioneering effort for government officials - mainly due to their cost. The early adopters within the service were the first to utilize this option – sending field data – numerical and visual within the IES.

Universal acceptance of computerized connectivity and its ubiquitous availability made e-mail a tool of first-choice convenience. Cooperation and collaboration was facilitated within the IES, with clients, service providers and between themselves. The issues involved remained focused on ICT proficiency, electracy and subject matter content. These are reviewed below.

1. b. Development and Adoption of the IES Internet site

In a sense the development of an IES Internet site complemented the e-mail connectivity evolution. Establishing it augmented IES activities. The site provided all Extension written materials and a communication service in a simple, cost effective format. A review of the early stages is detailed in Appendix E. A crucial point was to maintain a dynamic site format enabling end users to conveniently find what they needed rather than what Extension thought they should have in dictated information formats. Site categories were regional information, subject matter information, organizational details (e.g. a list of available courses and publications) and recommended contacts. Since budget constraints ruled out a permanent core group of Internet specialists to update the site and its' content the site development was outsourced. It was soon realized that the key site issues required assigning content priorities, indication and measures of information relevance, feed back facilities, a definition of needs, demands and their relevance. Technical issues were surmountable including an option to initiate and support common interest forums. The state of the art at the time dictated site rigidity, which over time (2009) became a non issue.

Being a government agency imposed an unexpected forum impediment. Due to security constraints accessing a forum on the IES site dictated circumventing the standard site formats. Regardless it was soon realized that these technicalities were easily overcome. The critical success factors in establishing and maintaining an Internet forum were dependant on the forum leader, the forum participants interest in it and with an emphasis the providers of information to the forum. In fact only one IES site forum remains active till today.

Looking back on Internet's contribution to IES the following main points are maintained to continuously evaluate the IES Internet site's efficiency and contribution to IES goals:

- Technical uptake problems;
- User benefits from using the site;
- Drawbacks from using the site;
- Critical success factors;
- Organizational aspects and responsibilities;
- Obstacles to use Internet for extension;
- Knowledge gaps and new trends if any;
- Proposed and/or potential development options;
- Additional issues of impact and/or influence.

2. From a Land-line phone in the office to an Office in the hand-held mobile

The IES has a highly specialized staff, at both local and headquarters levels. This currently reflects the professional level of many farmers as well. Adoption of ICT by research, extension and farmers meshes the interaction of all stakeholders. Consequently transferring, diffusing, teaching and introducing information and innovations to the farms is now a two, three or more way activity and undertaking. The result is that the traditional two-way model that restricts researchers to producing research results with Extension disseminating them is now only one possibility among many. Others include regional Farmer research activities, collaboration with non public extension by agri-business services, etc.

A recent random series of interviews with field extension agents elicited the following list of ICT contributions to their effectiveness:

- Real time, 24/7 direct and conference contact with farmers, clients, colleagues, research, markets, in Israel and abroad;
- A higher degree of independence in written communications and addressing recipients and dependency on secretarial services;
- Ongoing input, access, formal organizing and recording of data in the various digital and keyed in manner – including direct and remote numerical, visual, audio and other forms;
- Documentation of input including recommendations to farmers, reports of all sorts and their authentication;
- Real time access to data, records, information, colleagues and clients;
- Automatic extension functions – for example receiving and forwarding alerts and recommendations; data input, follow-up of instruction results, etc;
- Ongoing follow-up of trends in the field, in the market and results of e.g. plant protection or irrigation recommendations;
- Efficient on line statistical analysis, calculations, planning, photo analysis, etc;
- Efficient data presentation and accesses to remote presentation sources.

An individual mobile phone specifically facilitated in addition:

- extension staff availability;
- a short response time to farmers and other clients;
- effective field trip and time utilization;
- diminished dependency on "on the spot" presence;
- facilitation of impromptu consultations;
- ability to real time correct incorrect information and/or recommendations.

All these resulted in the opinion that the Extension officer is a "better" professional backed up by more and better information.

ICT availability has drawbacks which were attributed to an overload of information and requests for advice which impeded extension effectiveness, farmer receptiveness and imposition of an additional work load. Mentioned were:

- an overload of information;
- a possibility of widespread dissemination of incorrect information, non optimal recommendations and in the extreme spread of malicious disinformation;
- an unproductive demand on (officer, farmer, research, client) scarce time;

- a dependency on ICT involving loss of physical contact, intuition and precision of decisions.

3. Discussion and opinions: Ongoing challenges facing the adoption of ICT for Extension.

Since the initial IES management decision in 1979 to engage in CSE much has changed: some crucial innovations and related issues became none issues, basic proficiency constraints became irrelevant, the mix of agricultural products and their clients have changed, the profile of the "average" farmer and farmer extension needs have changed many times over, the international agricultural production terms of trade have changed, ICT capabilities have in many cases surpassed imagination, extension goals, specialists and specialization have changed – the list is almost endless - doing Rip Van Winkle proud.

Reviewing ICT Adoption for extension in Israel by the authors identified several fundamental issues - with an ongoing need for consideration, discussion and inclusion. The following lists several such issues as reflected in the current state of the IES ICT state of the art and issues yet to be resolved. These are offered to the reader for reflection and comments – all to be welcomed by the authors at their coordinates below.

- Innovative ICT supported systems are constantly enabling Extension and farmers to continue doing their respective activities more efficiently, with more sophisticated interactions and superior connectivity – at a cost. For example use of non optimal ICT. Correct selection of ICT systems and priorities and their use is imperative;
- Expectation from new ICT vs. adoption results can render initiative priorities irrelevant over time. An example is the planned training for adoption of e-mail, justification for the use of laptops, relevance of spreadsheets for farm management, permission to work from wireless served locations, etc.
- ICT can produce an overload of information, an overload of data entry dictates, non essential connectivity, distraction from essentials, loss of intuition in decision making, reliance on "popular" vs. verified information, shared but non specific field trial summaries, etc. Verified routines to handle these pitfalls must be part and parcel of Extension responsibility;
- ICT supported Extension as the go between Research, agents of change and early majority farmers is intensified and can be multi-directional. Specifically it may be farmer feedback that is the source of innovation, research may be guided by farmer real time needs, the source of innovation may be from abroad jointly evaluated by farmers, extension and research, etc. This changing multi-directional flow, its routine and evaluation needs constant verification – especially considering IES's comparative advantage as an agent of change itself;
- IES, due to Israel's small size, is characterized by familiarity – enhanced by ICT supported connectivity. For example: do ICT dictate to Extension agents their work routines e.g. 24/7 availability; to what extent does such intimate connectivity ensure individual ICT proficiency back up; is this

interdependence an advantage, an uncalled for burden to the initiated, is this to be encouraged?

- Convention suggests that "farmers are conservative" and "slow in innovation uptake". Yet to be resolved is the compatibility of this convention with unique farmer characteristics as ICT adopters. Variations abound;
- Organizational inertia and management resistance to change in various degrees are inevitable in any bureaucracy. IES basically avoided them by balancing bottom up ICT initiatives (e.g. IES's e-mail adoption) with top down priorities through the organization's internal interest group. Unfortunately this model has been abandoned – yet to be resurrected while considering management's three ICT Adoption options: to initiate, support or discourage future ICT adoption activities;
- ICT utilization tends to create communities - some of which may be within IES responsibilities. These include special interest groups, collaborative production efforts, rural communities, agricultural education groups, agricultural services including with/without international affiliation, complementing services and more. Although publicly funded, IES may not be in a position to serve these communities and/or be in a position to initiate new ones as needed. This dilemma essentially entails various collaboration efforts with unexpected partners – in Israel and abroad;
- How to measure the ICT benefits as attributed to extension results and Extension agent efficiency?
- How to evaluate and prioritize information systems for extension and their inherent information component? Namely - how to prioritize critical extension provided information with needs – from the farmer and/or public policy points of view?
- How to sustain familiarity and competence with newly developed ICT within IES derived extension methodology, Extension personnel ICT competence and "keeping up" compatibility with farmer (ICT) agents of change? The problem is aggravated by external ICT options such as the free use of a g-mail rather than a Ministry provided e-mail address or large scale agri-business ICT facilities not necessarily made available to IES.
- How to ensure compatibility of farmer needs with ICT development priorities, funding and allocation of extension subject matter expertise?
- To what extent should Extension be involved in technical ICT development – e.g. should Extension have computer programming capacity?
- To what extent is IES effectiveness dependent on ICT proficiency and compatibility with innovative farmer operated ICT. On example could be related to farmers practicing precision agriculture? In this sense does ICT proficiency today reflect farmers' competence, profitability and connectivity with Extension?

4. Summary

The Israeli Extensions Service's (IES) experience in adoption of Information and Communication Technologies (ICT) provides a comprehensive example of technological innovation adoption by a public service. Involvement of an internal Extension service interest group proved to be significant and demonstrated the potential benefit of "bottom up" participation in the innovation adoption process. The IES unique pattern of collaboration between research, extension and end users suggests areas of imitation and study of the efficiency of Extension as an intermediate agent of change. Identification of collaborating agents of change and their contribution to continuing successful ICT adoption by farmers, Extension and research cannot be overemphasized. With all that said ICT adoption remains an ongoing challenge for Extension and a prerequisite for attaining Extension's goals.

References

Elkana, Y., 2001. Extension services in Israel: a comprehensive report. "Technical Training for Rural Development: Looking to the 21st Century". Baoding, China,

EUNITA - European Network for Information Technology in Agriculture, (1997). Final report.

Gelb, E., Pollack, D., Spar, G., Reisman, A., Dinoor. A., (1976). Economics of Information: Leaf Rust case study. Case Western Tech. Report #375.

Gelb, E., Kislev, Y., (1982). Farmer's financing of Agricultural Research in Israel. Research Policy 11, 321-327,

Gelb, E., Kislev, Y., Voet, H., (1996). A computer in the milking parlor. Working paper 9805. The Center for Agricultural Economic Research, Rehovot, Israel.

Gelb E., Bonati, G., (1997). Evaluating Internet for Extension in Agriculture. http://departments.agri.huji.ac.il/economics/gelb-main.html

Gelb, E., Wagner, P., Rosskopf, K., Parker, C. and Schiefer, G. (2004). ICT Adoption - A Summary of the EFITA Questionnaires, Proceedings 4th AFITA Conference, Bangkok.

Gelb, E., Offer, A., (2005). "ICT Adoption in Agriculture: Perspectives of Technological Innovation". http://departments.agri.huji.ac.il/economics/gelb-main.html

Gelb, E., Parker, C., (2006). Is ICT Adoption for Agriculture Still an Important Issue? Proceedings, 5th AFITA Conference, Bangalore, India

Gelb, E., Levanon, D., (2008). Public Funding of Agricultural Research, Agricultural Research. Lowenstein, Thottappilly (Ed.) Springer ISBN-978-1-4020-6057 (e-book)

Gelb, E., Maru,A., Brodgen,J., Dodsworth E., Samii R.,Psece,V., (2008), Agricultural Development and Rural Viability GFAR Pre-Conference workshop summary, . IAALD/AFITA/WCCA (2008) at http://iaald-afita-wcca2008.org.

Gelb, E., Schmidt, J., Rauschkolb, R., (1985). Computer Supported Extension – US, Israel. Proceedings – US - Israel Workshop on Development of Computer supported Agricultural Extension. Pg 30 – 64

IAALD/AFITA/WCCA (2008). 12th World Congress of the International Association of Agricultural Information Specialists (IAALD), 6th Conference of the Asian

Federation of Information Technology in Agriculture (AFITA), 6th World Congress on Computers in Agriculture (WCCA). http://iaald-afita-wcca2008.org.

International Conference on Computers in Agricultural Extension Programs (1983). The Florida Cooperative Extension Service, the Institute of Food and Agricultural Sciences, the University of Florida, Gainesville.

Katz, S., Ben David, J., 1975. Scientific Research and Agricultural Innovation in Israel. Minerva 13: (2) 152-182.

Lehman,N., Regev, A., (2008), Agriculture in Israel: Fact and Figures. Ministry of Agriculture and Rural Development, Israel.

Loebenstein, G., Putievsky, E., 2007. Agricultural Research in Israel

NASS, USDA, 2007. Computer Use and Ownership Survey. http://usda.mannlib.cornell.edu/reports/nassr/other/computer/fmpc0705.pdf

Prahalad, C.K, (2004). The fortune at the bottom of the pyramid – eradicating poverty through profits. Wharton School Publishing.

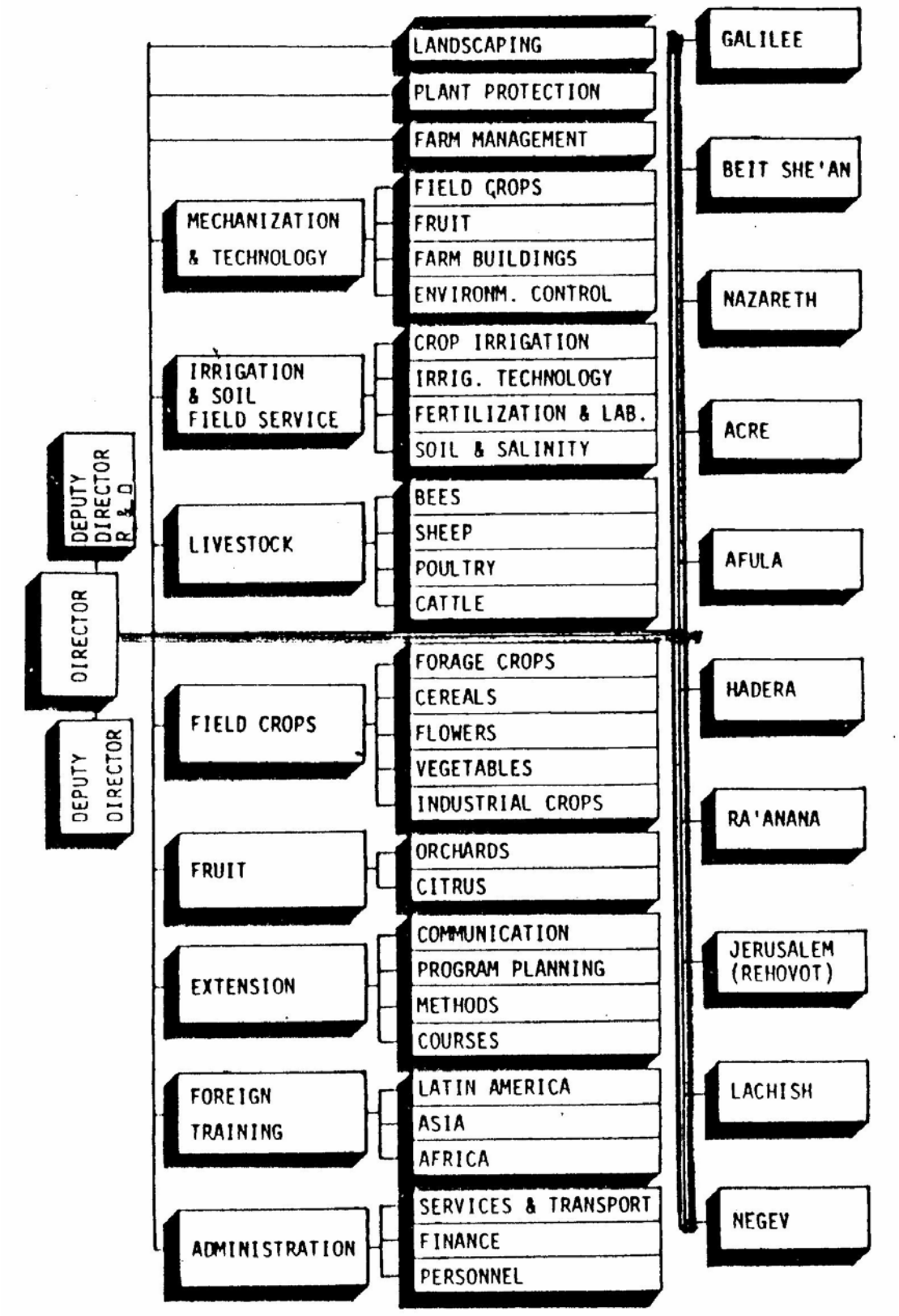
Rogers, E., (1962). Diffusion of Innovations. Free Press ISBN 0-7432-2209-1

Taragula, N., Van Lierde, D., Gelb, E., (2008). Information and Communication Technology (ICT) Adoption in Horticulture : Comparison of the EFITA, ISHS and ILVO Questionnaires. Forthcoming - ISHS symposium - Chiang Mai, Thailand

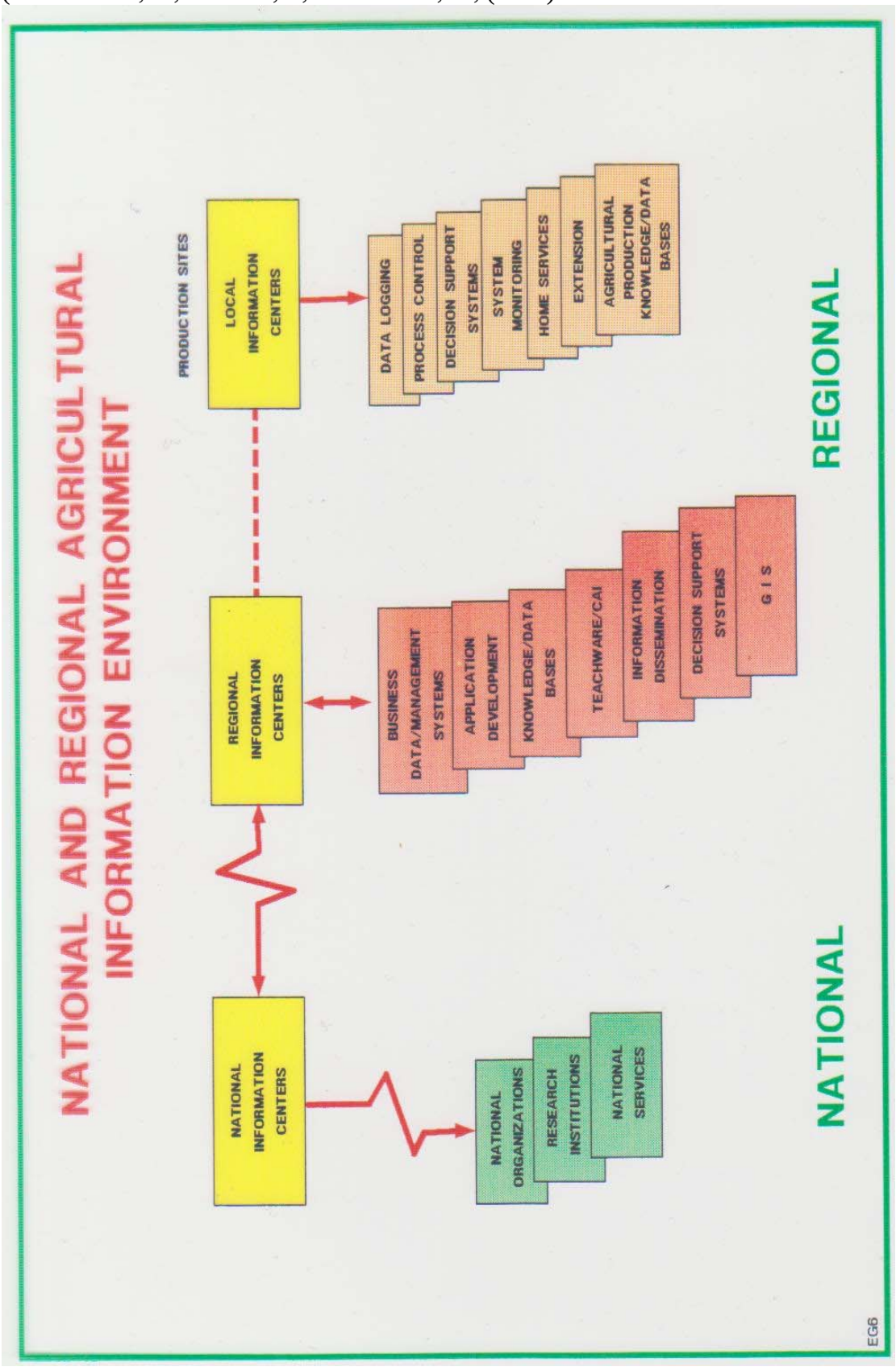
Appendix A. IAALD/AFITA/WCCA (2008) ICT Adoption recommendations compatible with Israeli IES experience

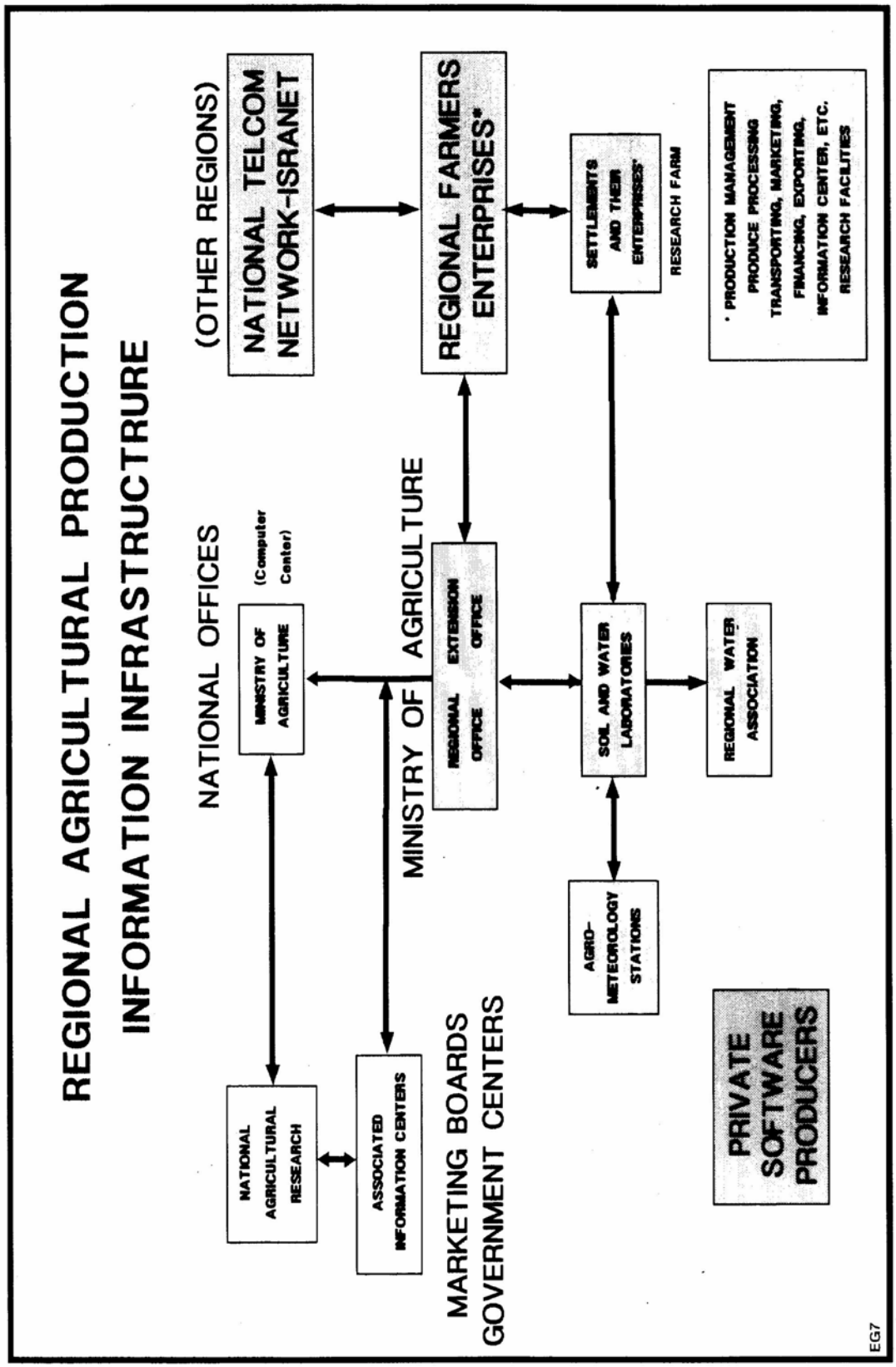
1. *ICT Infrastructure for rural areas must be part and parcel of all national infrastructure planning and programs;*
2. *ICT Adoption activities as a priority must encompass policy makers, ICT research and developers, end users/stakeholders and their communities;*
3. *Digital inclusion must be addressed as a policy priority and an infrastructure issue with the understanding that ICT penetration based solely on market forces is unlikely to eliminate digital exclusion;*
4. *Successful ICT Adoption is conditional on human capital development. This includes prioritizing extension and end user involvement in policy formulation and resource allocation;*
5. *Ensuring ICT compatibility with end user needs and national policies are to be included in all agricultural and rural development programs;*
6. *Ensure Connectivity (Individuals, communities) as a priority;*
7. *Create ICT Adoption Partnerships;*
8. *ICT Adoption is to be a priority in Rural viability development programs;*
9. *Management of information and its quality are as important as are the measures to assure the uptake of the ICT providing it;*
10. *Facilitate End-User Involvement in all ICT development and uptake programs.*

Appendix B 1 The Organizational framework of the Israeli Extension Service. The framework illustrates the Central Office specialized departments with experts supporting the subject matter officers in the regional offices e.g. Galilee. This framework outline has basically remained unchanged since 1965.
(Source: Gelb, E., Schmidt, J., Rauschkolb, R., (1985).



Appendix B 2. Israel'sAgricultural information Environment
(Source Gelb, E., Schmidt, J., Rauschkolb, R., (1985).





Appendix B 3. A regional Agricultural Production Information Infrastructure (Source Gelb, E., Schmidt, J., Rauschkolb, R., (1985).

Appendix C: ICT supported R&D in the Arava Regional Research program

The Arava is an area in the south of Israel, characterized by desert conditions, hot climate with a limited supply of water suitable for agriculture. The Arava Regional R&D ICT Center was initiated in the early 1980s and formally integrated in the regional R&D center in 1992. It has initiated over the years, and operates a large number of various ICT supported services. The center maintains the regional ICT infrastructure, provides technical services, supports tens of research projects held in trial plots, dedicated structures, greenhouses and other environments and manages the input of data regarding irrigation, crops, pests, product quality and more. The center employs three professionals – two technicians and a director who provide the ICT services to the Arava regional council. The center's main activities involve technical support, data management and information dissemination. A major effort is spent on early detection of ICT development flaws and system constraint in view costly remedial measures and scarce human capital.

The research management methodology and research decisions follow the national framework of decision making Loebenstein, Putievsky, (2007) with the regional elements considered and added on by the regional farmer's research committees Gelb, Kislev (1982). The regional research management is totally dependant on ICT supported tools as is the region's interaction with the national research programs. The bi – directional flow of data, information, research results and interim feed back to farmers, extension, scientists and service providers have made the region an agricultural success story.

The regional agricultural ICT infrastructure, 24/7, includes an extensive communication network and services, data, information and knowledge bases, computer supported control systems – e.g. greenhouse environmental controllers, irrigation, water recycling, fertilization management and fish pond management, data loggers, agro meteorology facilities and various computers and computer embedded devices.

Information management is the center's major activity. It involves collection of a wide variety of data types from a wide range of sources, verifying the data and processing it into reports. The information is then further processed for support of regional and individual operative decisions, input to knowledge bases and backed up for future use. Regional and national users and beneficiaries of the data include farmers, extension, scientists and service providers. The Information and Communication Technologies operated by the center and farmers involved are the most developed and innovative systems and equipment available on the market. Communication interactivity and information dissemination is both passive and active. This includes routine information e.g. weather and pest reports, current market data, extension recommendations and in turn research results and regional organizational information.

The extensive agricultural research activities in the Arava are managed by the Arava regional R&D center in collaboration with the regional ICT center. Both are publicly funded – mainly by the national Agricultural Research infrastructure and the region. Research results are evaluated by both entities mainly with the help of, and dependant on, ICT

ICT supported research programs and production feedback activities include a wide variety of subjects:

- A fruit fly eradication program supported by a computerized Geographical Information System (GIS);
- Regional greenhouse knowledge base management based on real time data input;
- On Line Research and production cost accounting;
- Online agro-meteorological stations with real time accessing;
- Real time product quality assurance with inventory control;
- Trial plot and research data monitoring;
- Plant protection policy and implementation follow-up;
- Regional agricultural parameter monitoring and follow-up;
- Ornamental fish growing research management;
- Growth, production, marketing and climate models – development and verification;
- Water quality monitoring and ongoing evaluation;
- Regional water balance monitoring.

The details in this appendix were gleaned from the 2006 report by I. Tzabari, the Director of the Arava R&D ICT activities.

Appendix D: The role of extension in developing a Management Information System (MIS) - The Cohen nursery case study

Expansion of the Cohen Nursery to 32,000 m^2 while exporting 34 million cuttings of 200 different flower varieties dictated the need for a MIS. Extension identified at the time the benefit to be gained by a Management System with a quicker response to customer orders, reduction of the necessary buffer stock and lower inventory margins. Specifically Extension pinpointed the main marketing and production problems - the follow up of orders; production to fit orders; shipment monitoring; invoicing control and accounting. Extension's contribution was to help with the system analysis, the definition of specifications, provision of horticultural knowledge and a sophisticated way of dealing with order confirmations. Extension did not finance the MIS development and was not paid - representing a public sector investment.

The software company delivered the initial MIS in 1993. Due to a change of programmers in 1995 they had to reprogram the MIS with a different software company. Being experienced they defined their specific needs clearly thereby considerably reducing development time and cost. The new program developers, in turn, intended to use their experience with the Cohen nursery to provide the new MIS to other nurseries - with their development costs covered - at a lower cost. Both these goals justified the continued involvement of Extension personnel. The reasons for the decision to expand Extension's involvement were:

- To help avoid the repetition of conceptual and horticultural mistakes;
- To encourage the development of a variety of MIS products;
- To assist software developers in developing a product compatible with needs;
- To encourage more software developers to enter the market;
- To reduce the cost of the end product to the farmer.

The revised MIS was demonstrated to other leading nursery managers who were in the process of either adopting this specific MIS or developing their own. Management

standards in nurseries were being refined accordingly. Evaluation of the results indicated that "tailoring" was feasible. The C/B analysis will be possible after a longer period, which will in turn enable a measure of Extension's contribution and its benefit. Extension's role was proved to be vital by ensuring a superior customized IT product with a proven benefit but the main question remains: Should the public pay, and till when, for developing farmer's management tools and training them to use them?

The Cohen nursery MIS experience indicates that the result justifies Extension's early involvement, initiation and evaluation of these systems. From this point onward Extension's experience and comparative advantage in matching MIS requirements with available program characteristics was evident. The Cohen nursery MIS development gave Extension a chance to intimately acquaint itself with issues involved in developing customized, small scale MIS without the need to be technically involved in programming. This methodology can be up-scaled, modified and shared with other types of programs.

To be specific the development steps taken were to:

a. identify a need;
b. identify available professionals that can carry through ICT development and adoption;
c. identify and engage them for implementation and necessary follow up;
d. transfer the results to the largest group of potential beneficiaries - within an existing local framework;
e. involve beneficiary's participatory financing.

A critical success factor is identification of agents of change – in this case the Cohen nursery. If however this type of involvement is expected of the Extension Service

a. what proficiencies should Extension acquire or have?
b. Should that specialized service be a source of income for Extension?
c. What is the limit of Extension's responsibility for the quality of the MIS?
d. What will be the demands for future involvement in development and implementation?

.

The answers to these and other questions are crucial at this point in time (1995) for Extension Services - in Israel and other countries - undergoing structural reviews and changes, dwindling public funding for rural sector development and donors under growing pressure to see through their projects till they bear fruit.

(Source: Wolfson, Gelb – 1995 internal IES report)

Appendix E. Internet Services for Agricultural Extension in Israel (an Israeli situation review from 1996 onwards)

Since the beginning of 1997 the IES has been running an intensive "adopting Internet" program. The purpose of this program is to turn Internet applications into a service routine which means including all 230 service subject matter specialists. During 1996 only about 40% of the specialists had access to Internet but only half of them used it as a routine.

Worldwide there are hundreds of agricultural Internet sites available, but virtually none of them benefit the Israeli farmer in his daily production - mainly because very few are written in Hebrew and relate to Israeli specifics. Most of the available sites provide general information while others developed by agricultural commodity suppliers were designed to serve their clients.

Additional local sites are under construction, designed to provide necessary information and knowledge to the Israeli farmers. All of them are funded by farmer organizations with the support of IES subject matter specialists ensuring an Extension component on site. An issue yet to be reconciled is the IES responsibility, if at all, for updating the information on the site and its impartiality. Sites providing Forums, Chat rooms, Advertising boards and Hebrew e-mail are being developed and will eventually suit IES's responsibilities and goals.

The current list of suitable Internet sites includes 4 background sites; a regional information site, two research institute sites and 3 agri-business related sites. None however provide specific agronomic recommendations or local product price details. Weather forecasts and news in general are available along with data from the Central Bureau of Statistics.

Internet use can compensate for the fact that an Extension specialist cannot provide all the professional information required by modern agriculture. Especially since Extension is expected, continuously to provide current and comprehensive answers on demand. Using the Internet as a communication infrastructure and information system is most cost effective, especially compared to establishing an in house alternative. With this in mind, and the needs and the opportunities so obvious, adoption would seem to be a simple task. In fact 8 months since providing the specialists with access to the Internet uptake is still slow, difficult and inefficient.

Our short experience using the Internet indicates that it is a perfect tool for Extension Service needs. It enables the following:

- exchange of information between specialist/specialized groups;
- exchange of information between specialist and the farmers;
- a short response time;
- integration of disciplines;
- accessing information from outside organizational sources, using the "net" as a source of information.

We found the critical success factors for Internet adoption to be:

- technological infrastructure;
- computer and Internet literacy;
- relevant and timely information availability;
- change in work habits;
- focused organizational effort.

(Source Y. Levi, 1997, condensed from a presentation at the Alberese workshop http://departments.agri.huji.ac.il/economics/gelb-sum-12.pdf

Author Information

E. Gelb
Affiliation: Center for Agricultural Economic Research, Samuel Neaman Institute for Advanced studies in Science and Technology
Communication Address: 9 Hagalil Street, Rehovot, 76601, Israel
Phone No +972 8 9411677
e-mail: gelb@agri.huji.ac.il

Former Chief Information officer of the Ministry of Agriculture and Rural Development in Israel responsible for Integration of ICT, research, information systems and applications into agricultural production, rural services, rural development and education; Information Systems and Information Technology policy coordinator; International cooperation and coordination - ICT systems development and implementation. Currently a consultant and lecturer on ICT in Agriculture and Rural Development. A member of various scientific committees and studies in Israel and abroad.

B. Gal
Affiliation: Ministry of Agriculture and Rural Development, Israel
Communication Address: P.O. Box. 28 Beit Dagan, 50250, Israel
Phone No: +972 3 9485349
e-mail: bragal@shaham.moag.gov.il
Head of the Extension Service Farm Management and Economics Department. Responsibilities include: Advising farmers, Farmers' Organizations, Extension, and Ministry of Agriculture departments; Promoting Information Technology (IT) adoption in the agricultural sector as well as within the organization;. Preparing cost accounting budgets and investment evaluations Conducting courses in Farm Management and Economics

D. Wolfson
Affiliation: Ministry of Agriculture and Rural Development, Israel
Communication Address: P.O. Box. 28 Beit Dagan, 50250, Israel
Phone No: +972 3 948 5649
e-mail: dwolfson@shaham.moag.gov.il

Senior Extension Specialist, Floriculture Division. Focused on Extension. Training Coordinator and Product's Quality Coordinating. Formally an Extension Specialist, Regional Office of Extension Service of the Ministry of Agriculture, Rehovot Israel - specializing in cut flowers and potted plants production; Plant protection Supervisor, Shemi nursery. Shedema Israel; Research Assistant, Department of Plant Protection, Agricultural Research Organization Volcani Center, Bet Dagan Israel