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December, 2000

Professor Dan Levanon
Chairman of the Board of Directors
BARD

Dear Professor Levanon,

RE: The External 20-year Review of BARD

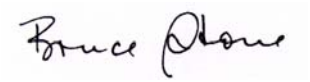
On behalf of the External 20-Year Review Committee, I take pleasure in presenting to you our report of the operations and effectiveness of the United States - Israel Binational Agricultural Research and Development Fund (BARD).

The Committee consulted widely in Israel and the United States, to obtain background information for the report. An economic survey by a binational consultancy team was commissioned to evaluate the commercial outcomes of a group of projects completed in the period 1988 to 1998. In addition, an in-house evaluation was undertaken of the scientific and technical outputs of projects completed during the review period.

The Review Committee found that BARD continues to provide important opportunities for the promotion and support of interactions between Israel and the United States in agricultural research.

The Report contains a number of recommendations concerning BARD's operations, foremost of which relates to the urgent need to secure the funds needed to maintain BARD's programs at an effective level.

Yours sincerely,



Bruce A. Stone
Chairman, for the 20-Year Review Committee

Members of the Review Committee:
I. Barash
R. J. Cook
P. R. Day
S. Fuchs

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Isaac Barash, Dean of the Faculty of Life Sciences, Tel Aviv University 1995-2000, Head of its Department of Plant Sciences (1980-84) and Chair, Department of Plant Pathology at the ARO's Volcani Center (1987-92). His research focused on the characterization of virulence determinants produced by plant pathogenic fungi and bacteria and, more recently, on molecular genetic aspects of plant-microbe interactions, concentrating on the transformation of an epiphytic bacterium (*Erwinia herbicola*) into a gall forming pathogen. Professor Barash is a Fellow of the American Phytopathological Society.

R. James Cook holds the R.J. Cook Endowed Chair in Wheat Research at Washington State University (1998-present) and served as an ARS research plant pathologist stationed at WSU (1965-1998). His research interests focus on wheat and barley root diseases, biological control, and direct-seed (no-till) cropping systems for dryland cereal based agriculture. His research team opened the way for understanding and managing antibiotic-producing bacteria in the root zone as an effective mechanism of defense against root diseases. Professor Cook was elected to the National Academy of Sciences, USA, in 1993.

Peter R. Day is Professor of Genetics and Director of the Biotechnology Center for Agriculture and the Environment at Cook College, Rutgers, University. He has conducted pioneering research in fungal genetics and host-parasite interactions. Dr. Day previously directed the Plant Breeding Institute in Cambridge, England where he encouraged the application of molecular biology to agriculture. Most recently his research interests have expanded to the use of new technology for environmental bioremediation and the public debate on the safety of genetically engineered food crops.

Sara Fuchs holds the Sir Ernst B. Chain Professorial Chair in Neuroimmunology, Department of Immunology, The Weizmann Institute of Science, and headed the Department of Chemical Immunology (1983-1985). Her research interests focus on molecular and cellular immunology, in particular research of autoimmune diseases and structure-function relationships of neurotransmitter receptors. Dr. Fuchs is the Weizmann Institute's Coordinator of the Pasteur-Weizmann program for Cancer research, and a member of the Council of Israel Science Foundation of the

Israel Academy of Sciences and Humanities. She is an elected member of the European Molecular Biology Organization (EMBO).

Bruce A. Stone, Chairman, is Emeritus Professor of Biochemistry at La Trobe University, Melbourne, Australia, formerly Dean of the School of Biological Sciences at La Trobe University and former chairman of the Australian Research Council's Biological Sciences Committee. Dr. Stone is currently the Assistant Director of the Crawford Fund for International Agricultural Research. He has continuing research interests in the biosynthesis of plant and bacterial β-glucans and in structure-function relationships of plant cell wall polysaccharides and proteins with special reference to their impact on ruminant digestion. Dr. Stone is a Fellow of the Australian Academy of Technological Sciences and Engineering and was chairman of the External Review of BARD conducted in 1998.

ABBREVIATIONS AND ACRONYMS

ARS, USDA	Agricultural Research Service, United States Department of Agriculture
ARO, MARD	Agricultural Research Organization, Ministry of Agriculture and Rural Development
BARD	United States – Israel Binational Agricultural Research and Development Fund
Committee	BARD External 20 Year Review Committee
CRGO	Competitive Research Grants Office (now the NRI-CGP),
CSRS, USDA	Cooperative State Research Service
CSREES, USDA	Cooperative State Research Education & Extension Service (merged CSRS and USDA Extension Service)
FA, HUJI	Faculty of Agriculture, The Hebrew University of Jerusalem
ICD, USDA	International Cooperation and Development
IOLR	Israel Oceanographic and Limnological Research Center
MERC	Middle East Regional Cooperative Program
MARD	Ministry of Agriculture and Rural Development (Israel)
MIF	Ministry of Finance (Israel)
NASULGC	National Association of State Universities and Land Grant Colleges
NRI, USDA	National Research Initiative
NRI-CGP, USDA	National Research Initiative Competitive Grants Program
NSF	National Science Foundation
OICD, USDA	Office of International Cooperation and Development (now ICD)
OIRP	Office of International Research Programs
PI, Co-PI	Principal Investigator, Co-Principal Investigator in BARD Collaborative Research Projects
REE	Research Education and Economics
SEA, USDA	Science and Education Administration
TAC	Technical Advisory Committee
US-AID	United States-Agency for International Development
USDA	United States Department of Agriculture

FIGURES, TABLES, LISTS

Figures

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Executive Summary

Statement of Mission and Summary of Findings

The BARD External 20 Year Review Committee (Committee) was commissioned to assess the effectiveness of BARD and its suitability as a mechanism for promoting and supporting binational agricultural research for the mutual benefit of the United States and Israel. The scientific, agricultural and economic outcomes of BARD sponsored research and the overall operations of the Fund were evaluated. The Committee also assessed the recognition and perception of BARD within the scientific and agricultural communities and made recommendations to the Board of Directors regarding the direction and continued operation of the Fund.

The Committee met three times between January 1999 and January 2000. Interviewees included BARD administrators, Board and Technical Advisory Committee (TAC) members, BARD grant recipients, panel members and university officials. In addition, the Committee received comments from interested persons by e-mail. An appraisal of the outputs of BARD-funded scientific research and an assessment of economic outputs of BARD projects were received.

The Committee concluded that BARD, using a modest budget over a 20 year period, can proudly claim to have selectively funded outstanding agricultural science activities, performed by leading researchers. BARD supported the training of some of the most promising young scientists in a broad research program that supports agriculture of mutual importance and relevance in the two countries and internationally. The Committee also found that:

- BARD research produces scientific and technical outcomes of high caliber. The Fund attracts submissions from researchers among the top echelons in their fields.
- The high number of technological and economic benefits to the agriculture of both countries justifies the program and its continued funding.

BARD is to be commended on the continued evolution of its operations to maintain standards of excellence and meet the current needs of the agriculture community. Nevertheless, the Committee found that the scope

of BARD's research support is in need of review to reflect developments and opportunities in non-traditional sectors of agricultural and biological sciences.

- The disposable funds available to BARD for support of their collaborative research program have reached a critically low level.
- BARD's operations have become a benchmark for binational agricultural funding between countries with comparable scientific and technological capabilities and common agricultural problems.

The Committee encourages the Board of Directors to continue to pursue strategies for augmenting BARD's income to enable BARD to continue its established goal of supporting high quality, mission oriented, collaborative research for the mutual benefit of the agriculture of the United States and Israel.

Background of BARD's Activities

Since the last External Review was completed in 1988, the activities of BARD have continued to be focused primarily on the support of mission-oriented, collaborative agricultural research projects in areas of mutual interest to the United States and Israel. Since BARD's inception, there have been 22 rounds of proposal submissions involving a total of 3,000 proposals, of which 850 were funded to a total of $186M. During the 10-year period under review (1988-1998), the distribution of funds approached *50%* for each partner country.

The support rate for all 22 rounds of proposal submissions averages *27%*, and for the period of this review, *24%*, with a record low in 1998 of *20%*. The Committee sees this fluctuation in the rate of support to be a result of the decrease in BARD's income and the gradual decrease in the purchasing power of the available funds. In no way does the reduced support rate reflect upon the quality of proposals submitted.

The range of agricultural research areas funded includes economics, engineering, animal production and protection, aquaculture, cellular and molecular biology, field, garden and horticultural crops, plant production and protection, postharvest and food science, soil, water, air and environment.

By far the greatest allocations have gone to research in biological sciences underpinning agricultural production (*82%*), and in particular during the review period there has been a burgeoning in the support of molecular genetic research across the agricultural spectrum. In other areas, agricultural engineers have made an impressive contribution, albeit with a relatively small proportion (*6.5%*) of BARD funds, as have soil scientists with only *9.6%* of the total allocation.

The United States' partners in BARD projects are from institutions in nearly every State and involve scientists from state universities and land grant colleges (*77%*), USDA-ARS (*15%*) and other private and public, not-for-profit research institutions (*8%*). In Israel almost *50%* of the allocations go to research partners in the ARO, another *25%* to the Hebrew University and the remainder to other universities and non-profit research institutions.

The Scientific Outcomes of BARD-Funded Research

The Committee commissioned an assessment of the quality of the scientific outputs of BARD-funded projects made possible by BARD's unique system of peer review of final reports. This assessment of the scientific merit of 520 completed projects, conducted by an experienced agricultural scientist showed that more than half were considered to be outstanding or excellent. Only a very few (*2%*) were considered to be of poor scientific merit.

Publications arising from BARD projects were also analyzed, in terms of the numbers and quality of research papers as judged from the “impact factor” of the journals in which they were published. The outputs, as measured in terms of published work, were considerable. Of the 380 projects completed over the past decade, more than 1,900 papers were published in more than 200 refereed scientific journals. Of these papers, more than *36%* appeared in high impact journals, including the most prestigious scientific journals, and another *30%* appeared in the top agricultural research journals in their respective fields. On average each BARD project resulted in five such papers.

Both evaluations show that BARD supports research of the highest quality. In the 20 years since BARD's initial round of funding, many scientific and technological advances have resulted from its funded research. Through the analysis of the scientific outcomes, and the evidence from the summaries provided by the funded scientists, the Committee saw many examples of

BARD-supported work that are now recognized as the basis of advances in agricultural science. Project summaries, including research publications, are included in the Annex.

Brief synopses of developments arising from some of these BARD sponsored projects follow:

Agricultural Economics: BARD has funded approximately 30 research projects in agricultural economics over the past 20 years. The value of these projects stems from two sources: 1) the value of information in reducing uncertainty on the part of decision makers, be they policy makers or producers; and 2) scientific merit, through refined theories and methods that improve subsequent applied analyses. Projects supported by BARD have primarily been of the latter type, although some have produced results that have been applied by decision makers.

Animal Production: BARD has supported a portfolio of successful projects on topics related to the improvement of animal production. Amongst these are quite basic studies aimed at reducing the caloric and fat content of beef and other red meats through genetic manipulation, as well as contributions to the understanding of bovine reproductive behavior and thermotolerance in cattle. In poultry, some notable outcomes were realized in reducing to practice research findings on the effect of early feed restriction on chicken growth. Basic information was generated on eggshell formation in relation to shell thickness.

Animal Health and Welfare: BARD supported continuing and productive collaborations with significant outcomes in molecular and immunological aspects of several important cattle diseases: babesiosis, brucellosis, and bovine leukemia virus. The outcomes include the design of improved approaches to diagnosis and vaccination. Other high impact projects dealt with Marek's disease and tibial dyschondroplasia in poultry.

Aquaculture and Algal Culture: Some of the earliest BARD proposals supported very successful research related to the genetics of fish production and the creation of transgenic fish, notably tilapia, carp and catfish, and to the hormonal manipulation of fish reproductive cycles. Parallel projects in improvements in fishpond aeration (see Economic Survey, Executive Summary) have made realistic the establishment of an aquaculture industry in the southern United States. Cognate projects on the culture of single-celled algae as sources of growth factors for fish and for the food industries

have led to a delineation of the basic synthetic pathways for these growth factors.

Genomics and Breeding: BARD-funded projects provided important initial inputs for genomic approaches to genetic improvement of agricultural species (both animals and plants) using DNA-based marker assisted selection. These have led to important advances in genetic manipulation of traits of economic importance that have impacted on breeding worldwide. While selection for rapid juvenile growth rate in poultry has significantly reduced the cost of production of a kilogram of meat, it is associated with poor disease resistance and reproductive performance. This led to research using classical approaches in BARD-sponsored projects on the genetics of immunological maturity and the genetics of minimum body weight for onset of sexual maturity. In bovine research, the “grandaughter-design” has become the standard used worldwide for detection of genes affecting quantitative traits. In plants, genomic mapping and transformation have led to significant advances in creating disease resistance and improved quality of grapevine, tomatos and other agriculturally important species. QTLs with significant effects on improved yield and quality in tomato are now in use by Israeli and US seed companies who are adopting marker assisted selection methods.

Agricultural Engineering: Machine vision equipment for real time quality-inspection and sorting of fruits and vegetables is an outstanding BARD success story. Another project whose outcomes include methods for management of greenhouse environments has generated a comprehensive model (TOMGRO) applied to tomato crops, that is accepted as the standard world wide. The invention of an aerodynamic/electrostatic method to deliver fine particles (chemicals, pollen) is the outcome of additional BARD funded projects. Use of this method allows a three to six fold increase in particle deposition and result in 50% reduction of pesticide dispersal per unit of land.

Plant Production: BARD supported research on fundamental aspects of the photosynthetic process. Important outcomes include the understanding of the action of herbicides on thylakoid function, the mechanism of photoinhibition of photosynthesis and the assembly of the photosynthetic apparatus. Outstanding outputs were forthcoming from a series of BARD projects on cell wall synthesis and its control: these led to the first cloning of a cellulose synthase in higher plants. Ground-breaking research on

plasmodesmatal communication between cells resulted in an understanding of proteins involved in the movement of macromolecules, including plant viruses from cell to cell. Other studies revealed how ion uptake by plant cells is regulated through the interaction of light receptors and the biological clock. Plant quality improvement through molecular plant breeding has been directed in several projects to the development of stress tolerance, to improvement of wheat seed protein quality, to the tolerance of wheat plants to heat, to sugar accumulation in fruit and to sweet corn quality and blight resistance. The demonstration that water-soluble phenolic compounds liberated by plant roots into the soil stimulate the germination of spores of mycorrhizal fungi has led to their use in enhancing the establishment of peanut and garlic plants. Each of these projects was made possible through the enabling technology generated in the original BARD-supported work.

Postharvest and Food Science: The understanding of the molecular basis of bitter taste in fruit products was enhanced by the demonstration of two novel mechanisms of signal transduction in sensory perception engendered by bitter taste compounds. Fundamental studies on the mechanism of lipid oxidation in muscle foods have shown that dietary vitamin E supplementation is a more practical way of stabilizing muscle tissue than withdrawing iron supplementation. A new approach to the biocontrol of postharvest fungal diseases of avocado has been made possible by the recognition of methods that can stimulate the production of antifungal compounds in the peel. Another biocontrol strategy relies on the observation that naturally occurring yeasts on citrus fruits are antagonistic to postharvest spoilage organisms. An understanding of the biochemistry of shoot growth has allowed the demonstration of an effective means of eliminating the gravitropic responses (stem bending) in cut flowers.

Plant Protection: The molecular basis of transmission of economically important viruses between insects and plants was elucidated. Innovative research led to a more complete understanding of aphid and thrip vectors of destructive plant viruses. Understanding the action of pheromones in cabbage looper moths has created a potential for their control in the field. Nematode surface molecules necessary for interaction with plant roots were elucidated and may lead to a control strategy. Nematodes themselves parasitize insects and their use in insect control has been explored. The soil-inhabiting fungus, *Trichoderma harzianum*, was developed as a biological control agent for root pathogens and is now a source of transgenes for development of crops with resistance to root pathogens. These outcomes

trace back directly to fundamental and applied research supported by BARD.

Soil Science: A transport model was developed to describe the movement of water in the soil-water zone above the water table and to assist in the management, prevention and clean up of agricultural ground water pollution or in waste management. The interactions between water flow and root distribution has been described and will permit informed soil-water status monitoring and sound irrigation decision making.

The Impact of BARD Research on the Agriculture of the United States and Israel

BARD research was also scored for its measurable benefits to agriculture in the United States and Israel, using peer review of the final reports. This commissioned review of projects included the peer review scores and an aggregate score for agricultural benefits realized after the completion of the project. Of the 520 completed projects examined, nearly 190 were identified as having direct or very promising benefits to agriculture, justifying the characterization of BARD as a fund with substantial benefit to agriculture.

Examples of research funded by BARD with high impact on agriculture include projects in the following areas:

Agricultural engineering

- Implementation of electronic sorting and grading of fruit, and robotic harvesting of fruit.
- Reduction of production costs through automation of greenhouse management.

Agricultural production

- Introduction of new commercial cut flower species.
- Optimization of poultry production by feed restriction.
- Introduction of a practical system for cooling dairy cattle leading to improved summer milk production.
- Elimination of gravitropic responses (stem bending) in cut flowers.
- Optimization of vine microclimate, crop yield and quality in table and wine grapes.
- Development of heat tolerant wheat varieties.
- Development of contained agriculture (“plasticulture”) for production of vegetables.

- Inhibition of chilling injury and delayed ripening techniques.
- Postharvest improvements to reduce decay and extend shelf life of harvested fruit.

Aquaculture production

- Introduction of tools for the manipulation of fish maturation.
- Creation of all-male fingerling stock by sex reversal.

Pest and disease control

- Pheromone attractants for cabbage looper moths.
- Use of agricultural and municipal wastes for preparation of disease suppressive composts.
- Post-planting control of soilborne pathogens in fruit tree crops.
- Solar heating (solarization) of soils and introduction of improved strains of Trichoderma spp. as methyl bromide replacements in the biocontrol of soilborne pathogens.
- Enhanced mycorrhizal spore germination leading to better symbiosis in vegetable crops.

Improved breeding through molecular genetic techniques

- Increased efficiency in poultry and channel catfish production.
- Development of marker assisted selection technologies in plant and animal breeding.
- Molecular genetic techniques for evaluating dairy sires.

Agricultural economics

- Implementation of strategies for the economic distribution and use of water.

Soil science

- Development of practical guidelines for the proper management of drip irrigation.

Food science

- Biocontrol of postharvest spoilage organisms on citrus and deciduous fruits using naturally occurring yeasts.
- Understanding of bitter taste in citrus juice.

The Economic Outcomes of BARD-Funded Research

The majority of BARD projects are directed towards strategic or applied pre-commercial studies. Still, a large number have already had outputs with

applications in commercial agriculture. Ten such projects were subjected to detailed qualitative and quantitative evaluation by an independent United States-Israel team of agricultural economists.

To select the projects evaluated in this report, some 500 completed BARD projects were first screened for potential commercial impacts. Those with the most promising and potentially measurable economic returns were selected for further evaluation. Following this, the BARD management conducted a round of screening, reducing the project pool to 60. Subsequent discussions among BARD management and the US-Israeli economic evaluation team reduced this set of projects to 25 and finally to 10. These 10 projects were subjected to detailed quantitative evaluation. Information was gathered from project scientists, non-project scientists and representatives of relevant industries. Cost-benefit analyses were conducted.

The economic survey, concluded that the ten projects evaluated are already producing benefits to Israel, the United States, or both countries. The report concludes that the expected aggregate benefits of these projects alone (nearly $783M for the two countries by the year 2010) exceed the total expenditures of BARD ($186M) since its inception 20 years ago. If the benefits from the five projects evaluated in the previous ten-year review are included, the outcomes of fifteen projects greatly exceed the discounted value of the investment in BARD. No doubt, many of the remaining 835 projects funded by BARD have also generated or will generate economic benefits. Therefore, it is reasonable to assume that the total commercial impact of all projects can be estimated at being several times higher, possibly even an order of magnitude higher, than the figure presented by the external economic review team pertaining only to the ten selected projects.

BARD also finances a significant amount of postdoctoral training, graduate student support, international exchange, and permanent equipment where calculations of direct economic benefits are virtually impossible but clearly must be substantial.

While the monetary value of the impact of a given project is sometimes not equal in both countries, BARD research has significantly impacted specific industries in both countries. Examples include work in the poultry industry through work on poultry feed restriction, the intensive aquaculture industry through improved aeration systems, the fish production industry through

breeding, and crop production industries through genetic improvement of crop varieties.

Scientific and technical outcomes are difficult to evaluate in any time frame of less than 15-20 years. But clearly the already high number of scientific advances from BARD-funded research and the benefits of this research to the agriculture of the two countries, is justification enough for the program and its approach to funding research.

BARD's Operations

Proposal Evaluation and Selection Process

BARD works with a two-tiered evaluation system consisting of subject panel areas and the Technical Advisory Committee (TAC). The 20 Year Review Committee followed the independent work of the US and Israeli subject panels, and observed the operations of the single binational TAC. The Committee found that there is agreement amongst those who have served in the selection process as well as recipients, administrators and unsuccessful applicants, concerning the high degree of integrity and fairness of the procedure. The Committee believes that the criteria in use for selection of the most fundable projects are sound and that the recent stronger emphasis on 'potential for fruitful collaboration' is appropriate.

Recommendation 1: That the selection of fundable proposals continue to be based on scientific merit, benefit to agriculture of both countries, potential for fruitful collaboration between US and Israeli investigators and probability of success within the lifetime of the project.

The Committee commends the recent introduction of the use of a single set of external reviewers by the evaluation panels in both the United States and Israel. The Committee further commends the recent changes in eligibility criteria for members of TAC. Several detailed suggestions for amendments to the proposal evaluation and selection process and others supporting the *status quo* were received. The Committee noted that, whereas the two-tiered selection system has been retained in principle, the process has evolved during the life of BARD.

Recommendation 2: Whereas the Committee endorses the two-tiered system (subject panels and TAC), there are a number of possible modifications that may increase the efficiency of the evaluation and selection process. The Committee therefore recommends that the Board of Directors, in consultation with TAC and the Executive Director, seriously consider options for modification of the current procedures.

The Committee noted that there appears to be a gender imbalance in the make up of the review panels and TAC. While taking into account the relative number of qualified women scientists in the agricultural research communities of the United States and Israel, the Board of Directors, Executive Director and TAC should address this imbalance when making future appointments to panels and TAC.

Recommendation 3: That BARD takes steps to redress the marked gender imbalance in the review panels and TAC.

Retrospective Project Evaluation

BARD is unique amongst competitive grant programs in following a process of retrospective project evaluation. The Committee strongly endorses this practice and notes that, without the final reports and their review, BARD cannot properly assess the success of its collaborative research program. The final reports were an invaluable aid to the Committee in the assessment of scientific outcomes and outputs of the research. The final reports will continue to provide an important means of judging the effectiveness of research supported by BARD.

The Committee also found that the final reports were overly long. It was noted that the timing of receipt of the final report is usually too early to allow recording of the true outputs and outcomes of the project. This was borne out by an inspection of supplementary reports from completed projects that were assessed for scientific merit. Annual updating of outcomes and outputs arising from projects would keep the database current.

Recommendation 4: That the body of the final report be limited to three pages plus a list of published, accepted and submitted manuscripts, abstract and details of M.Sc. and Ph.D. theses arising from the project.

Recommendation 5: That BARD annually requests previous grant holders to provide information about publications, patents and application of research findings arising from their completed projects.

The Committee believes that it would be more useful if TAC members reviewed the final reports. This would also provide TAC with an indication of the success or otherwise of previously supported projects.

Recommendation 6: That the procedure for peer review of final reports be modified and that TAC is involved in the process.

Project Administrative Process

Responses received concerning the project administrative process showed that both grant holders and administrators are well satisfied with the grant-handling process and the prompt and responsive attention to their queries. The BARD administrative team is to be commended for their effectiveness and efficiency in handling the day-to-day operations. Electronic handling of much of the office traffic has been implemented and further improvements in this medium continue to be developed.

Collaborative Aspects of BARD Projects

The essential philosophy of the BARD scheme in joining agricultural scientists from the two countries in common scientific pursuit has, through the synergies, complementarities and the mutual support engendered, delivered outputs and outcomes not possible had the scientists worked separately. It was noted, however, that for some projects the collaborative interactions were more apparent than real. Greater scrutiny of this aspect by the evaluators of projects may be needed. The Committee endorses the recent addition of a proposal assessment criterion to emphasize the importance attached to collaboration.

The potency of BARD collaboration is illustrated by some of the superb outcomes from its research, as revealed by the assessment of scientific outcomes and the economic survey. The strong connections built between the collaborating scientists are expressed in ways that often continue beyond the lifetime of the grant. These include the integration of multidisciplinary research, exchange visits to Israel or the United States, combining fundamental expertise to solve practical problems, better understanding of the two cultures, and more. Collaboration is stimulating and positive even

when not funded. Long-term relationships are fostered and communications are improved; it has been noted that "just writing the application jointly increases the information exchange".

Type and Scope of Research Projects

BARD does not issue guidelines on the type of research to be supported, but inspection of the portfolio of projects suggests that more than *80%* may be classified as basic or strategic (mission oriented) research and the remainder as applied research.

BARD is the single most important source of strategic research funds for agricultural scientists in Israel. Consequently, many agricultural scientists in Israel must have a US co-PI if they intend to compete for funds to conduct basic or strategic agricultural research in their own country. This remarkable situation benefits the US since, by definition, many Israeli scientists can only get funding for their agricultural research if their project will also benefit US agriculture. The situation is also of benefit to Israel because of the number of US investigators that must be attracted to conduct agricultural research of importance to Israel. Any disproportionate impact applies more or less to both countries, where some areas of R and D have benefited Israel more than the United States, while other areas have benefited the United States more than Israel. The economic survey shows that, overall, the agriculture of both countries have benefited enormously from BARD-funded research.

The Committee noted that the implementation of the BARD and USDA competitive grants programs has had a permanent impact on the funding of agricultural research in Israel and the United States. The impact in the United States has probably been somewhat less than that in Israel because of the continuation of appropriated funds, such as for ARS, the formula funds (Hatch and McIntire-Stennis) and State appropriations to agricultural experiment stations (AES). The switch from 'hard' to 'soft' funds for research, with only the salaries of researchers paid by the institutions, has allowed creative scientists to expand their capacities as researchers, to recruit postdoctoral fellows, graduate students and assistants and to pursue their specific ideas.

Fellowships and Workshops

Postdoctoral Fellowships

Since 1985, BARD has awarded 106 postdoctoral fellowships (90 to Israeli

and 16 to US scientists). It is regrettable that in the last decade very few US citizens have applied. Notwithstanding this asymmetry, it is an outstanding program of very high quality, and has provided an opportunity for bright, well-prepared young Israeli scientists to participate in US research projects. Its manpower contributes to the United States' agricultural research effort and at the same time, trains a new echelon of Israeli agricultural research workers. To that extent there is mutual benefit.

Recommendation 7: That the award of Vaadia-BARD Postdoctoral Fellowships continue.

Senior Research Fellowships

As a partial redress to the imbalance in postdoctoral fellowship awards to US and Israeli candidates, a Senior Research Fellowship program was introduced in 1990 and to date, five have been awarded. These Fellowships are available to citizens of the United States who are established research scientists and who wish to spend from three to twelve months in an Israeli laboratory pursuing an approved agricultural research project. The objectives of the program are to promote cooperative agricultural research between Fellows from the United States and scientists in Israel and to provide BARD with input into advanced research areas while enhancing scientific competence in these areas.

Recommendation 8: That the Senior Research Fellowship program continues in its present form, but its scope be widened and the minimum period of tenure be reduced to one month.

Workshops

A continuing and significant activity of BARD has been the fostering of exchanges of ideas and expertise in areas of developing agricultural science through the support of scientific workshops. Since 1988, BARD has funded 16 workshops that have identified new research directions while fostering liaisons between US and Israeli participants. Additionally, non-US or Israeli participation has been encouraged, and delegates from Israel's Middle Eastern neighbors and elsewhere have been included. BARD policy is to fund independent or "stand-alone" workshops on topics related specifically to the programmatic areas that make up BARD, rather than funding sessions or components of larger meetings organized by other institutions or scientific entities. Reference to specific workshops is made in several of the project summaries.

Recommendation 9: Workshops should be funded as independent or "stand-alone" activities and under current guidelines for scope and selection criteria. The mode of publication of the proceedings should remain optional, depending upon the workshop.

The Funding of BARD's Activities

Funds for the support of BARD research and other related activities arise from two sources, both of which are contributed in equal parts by the governments of the United States and Israel: a $110M endowment fund and, since 1994, an annual, direct supplement. The interest on the endowment fund has declined since 1984 and the amount of the annual supplement of each country has been reduced from $2.5M in 1994 to $800,000 in 1999. The purchasing power of the dollar over the years has also declined. As a result, while BARD continues to receive large numbers of meritorious proposals, it has been able to support fewer of them (27% over the 22 submissions but only 23.7% for the years 1988-1998 and 20% in 1998) and at a reduced per-proposal. The situation is chronic and its redress is critical to the existence of BARD. A number of approaches might be taken to address the budget shortfall, but ultimately it means convincing budget formulators of the contribution the collaborative program has made, and can make, in bringing returns in knowledge, innovative technology and training to improve agricultural performance in both countries and in the Middle East and North American, more generally.

To restore the capacity of the Fund to its 1989 funding level, the income will need to be readjusted to around $14.5M per annum in 1999 dollar terms. This would be sufficient to fund 40 new research projects at $55,000 per year on each side, as well as a number of postdoctoral and senior research fellowships and workshops.

Recommendation 10: That the Board of Directors consider options and devise strategies for augmenting disposable funds to around $14.5M. This would allow the funding of 40 new projects per year at an average annual value of $55,000 for each partner, 8-10 fellowships, as well as a workshop and the administrative overheads.

Operational Features

Publicity

BARD communicates with the general public through its newsletter and its

website. Both media are important and their use should continue. The linking of the BARD website to relevant professional societies would be a useful extension.
Notwithstanding the fact that BARD's budget for the support of agricultural research and development is divided almost equally between the US and Israel, there is a persistent mis-perception that BARD funding favors Israel. This is incorrect and should be clarified in public relations exercises.

The Committee believes that BARD needs to extend its publicity and communications by strengthening the interactions between the Board of Directors and representatives of the agricultural community, administrators and policy makers involved in budget formulations, especially in the United States, where BARD seems to have lost some visibility.

Recommendation 11: That BARD continue its efforts in publicity and communication of the philosophy and practice of BARD funding to consolidate its image, especially amongst administrators and budget formulators in both countries. The positive aspects of the collaborative funding should be emphasized and the incorrect negative perceptions of an imbalance of allocations between the partner countries countered.

Recommendation 12: That the Board of Directors commissions an article for publication in a widely read journal describing the goals and successes of BARD.

Future External Reviews
The regular overviews of BARD by independent assessors has proven useful to the Board of Directors and Executive Directors in making appropriate adjustments to BARD's operations and its direction and scope.

Recommendation 13: That an independent "mini" review of BARD's operations takes place in 2004.

Report of the Committee

1. Introduction

1.1. Objectives of the Review

The BARD External 20 Year Review Committee (Committee) was commissioned to assess the effectiveness of BARD and its suitability as a mechanism for promoting and supporting binational agricultural research for the mutual benefit of the United States and Israel. The quality of the scientific, agricultural and economic outcomes of BARD-sponsored research and the overall operations of the Fund were evaluated. The Committee also assessed the recognition and perception of BARD within the scientific and agricultural communities and made recommendations to the Board of Directors regarding the direction and continued operation of the Fund.

1.2. Review Methodology

To accomplish these objectives, the Committee met formally three times: January 1999, for three days at the BARD offices in Bet Dagan, Israel; April 1999, for three days in Lincoln, Nebraska, concurrent with the Technical Advisory Committee (TAC) meeting; and January 2000 in Chevy Chase, Maryland, also for three days.

At the formal meetings there were consultations, interviews and dialogue with members of the agricultural science community, senior administrators of agricultural research agencies and institutions, individual members of the Board of Directors, TAC members, and members of the BARD administrative staff. Individual committee members also gathered information and views throughout the duration of the Review. An internet site was established to receive comments on BARD's operations from interested agricultural scientists and administrators.

The Committee commissioned an expereinced agricultural scientist to conduct an assessment of the quality of the scientific outputs and potential agricultural impact of some 520 BARD projects completed in the period 1988-1998. In addition, a consortium of US and Israeli agricultural economists was commissioned to survey the economic outcomes of BARD projects in the same period. Statistics on BARD's operations were provided by the BARD administration.

2. BARD's Objectives

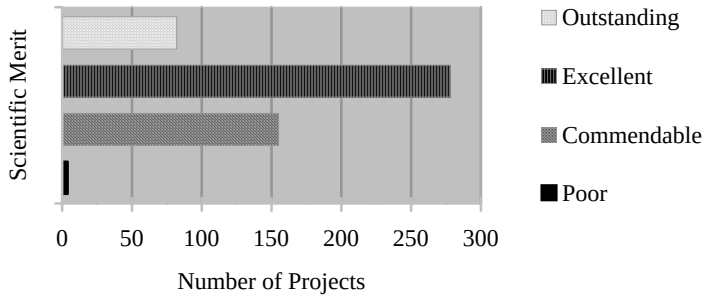
The United States-Israel Binational Agricultural Research and Development Fund (BARD) was established in 1978 to promote and support agricultural research and development activities of mutual benefit to the United States and Israel. These activities have centered principally on the support of collaborative research in areas of agriculture of common interest to both countries, but have also included support for postdoctoral training and scientific workshops to promote information exchange and to seed collaborative projects. BARD's operations have become a benchmark for binational agricultural funding between countries with comparable scientific and technological capabilities and common agricultural problems.

3. Contributions and Impacts (Scientific, Agricultural, Economic)

3.1. Scientific Impact – Outputs and Outcomes

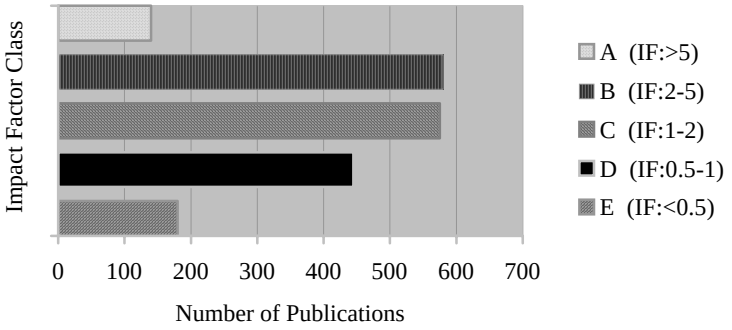
The commissioned assessment of the quality of scientific outputs was made possible by BARD's unique system of peer review of final scientific reports. On the basis of routine peer assessments of the scientific merit of the projects evaluated, *15%* were classified as outstanding, *52%* as excellent, *31%* as commendable and only *2%* as poor *(Figure 1)*.

Figure 1: Scientific Merit of Reviewed Projects



In addition, publications arising from BARD projects were analyzed according to the numbers and quality of research papers as judged from the current impact factor (1996 Journal Citation Record) of the journals in which they were published *(Figure 2)*. The outputs, measured in terms of published work, were considerable. They include 1,900 papers published in more than 200 refereed scientific journals. On average each BARD project resulted in five such papers.

Figure 2: Refereed Publications Derived from Projects, by Impact Factor



Of these papers, more than *36%* appeared in high impact journals including *Science* (5), *Proceedings of the National Academy of Science, USA* (16) and *Virology* (19). Some 45 additional articles were published in other high impact journals such as *Cell, Plant Cell, J. of Virology, Nature Genetics, European Molecular Biology J., FASEB J.* and others. Clearly, BARD research findings are included in the most prestigious scientific journals. Another *30%* appeared in top agricultural research journals in their respective fields including such journals as *Applied and Environmental Microbiology, Biological Reproduction, Genetics, Infectious Immunology, J. of General Virology, Mammalian Genome, Phytopathology, Plant Molecular Biology, Plant Physiology, Theoretical and Applied Genetics* and others.

Both evaluation approaches showed that BARD supports research and development of high caliber and attracts submissions from researchers many of whom are recognized as being in the top echelon in their fields. These semi-quantitative appraisals provide an overview of the magnitude and impact of the best of BARD's projects. it is not possible to use these results in a comparative way since, as far as the Committee is aware, no other similar funding agencies collect statistics relating to the success of its funded projects.

The principal investigators of projects falling in the top scientific merit group ("outstanding") were asked to provide an up-to-date, retrospective account of the work performed under their BARD grant. Specifically, they were asked to indicate outcomes, i.e. application of results, methods or approaches to understanding problems that are basic to agricultural

production or that may be directly, or indirectly, applied to overcome or alleviate an agricultural problem or provide a new opportunity for agriculture. Summary digests of these projects, indicating both outputs and outcomes, are reported in the Annex. Some of these projects are already leading to direct practical applications and producing economic returns; others have laid or are laying the foundation for future application and development.

BARD has continuously supported important work on conventional and biological control of plant and animal diseases, including the molecular biology of the laboratory fruit fly and its application to the medfly; basic and strategic research on the interaction and control of virus, insect and fungal attacks on crops; the molecular and immunological aspects of common cattle diseases; and the design and implementation of improved approaches for the diagnosis of such diseases and their control by vaccination. BARD has assisted a crucially important development in the application of marker assisted selection technologies in plant and animal breeding. This approach, used first with tomato, is already seen as having great practical significance for breeding a wide range of crop plants. BARD supported a pioneering program in quantitative cattle genetics to increase the value of breeding stock and the use of molecular markers has assisted in evaluating elite dairy sires. BARD has also supported work on poultry nutrition, physiology of bone growth and eggshell formation and the genetics of immune response and reproductive performance. Also supported was the basic research that laid the foundation for the development of drip irrigation.

Scientific and technical outcomes are difficult to evaluate in any time frame of less than 15-20 years. Still, the assessment clearly shows the already high number of scientific advances from BARD-funded research and the benefits of this research to the agriculture of the two countries. This is justification enough for the program and its approach to funding research. The advances attributable to BARD-funded research are at least as significant scientifically and probably more significant practically than, for example, the combined and highly productive photosynthesis and genetic mechanisms programs of the original Competitive Research Grants Office (CRGO) or the combined biological stress programs of CRGO, (where annual funding has been roughly comparable to that for BARD). In addition, the competitive review process and the resulting quality check on the science

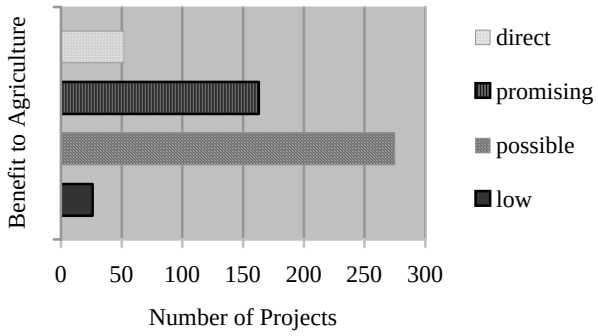
improves the entire program of the investigators, even when the funds from BARD represent only part of the total cost of the program.

The fact that BARD represents the single most important source of basic or strategic-basic grant funds to agricultural scientists in Israel creates a unique situation for both countries. This means, in effect, that many agricultural scientists in Israel must have a US co-principal investigator (PI or co-PI) if they intend to compete for grant funds to conduct agricultural research in their own country. This remarkable situation benefits the United States since, by definition, Israeli scientists can get BARD funding for their agricultural research only if their projects will also benefit US agriculture. This situation is also of benefit to Israel because of the number of US investigators that must be attracted to conduct agricultural research of importance to Israel.

3.2 Agricultural Impact

In addition to the evaluation of scientific merit, all BARD proposals are scored in the peer review of the final reports for their anticipated benefit to the agriculture of the United States and Israel. Of the 520 completed projects examined, substantial evidence of benefit to agriculture was apparent *(Figure 3).* Nearly 200 projects were identified as having direct, or promising benefits, to agriculture. This justifies the characterization of BARD as a fund with substantial benefit to production agriculture in both the United States and Israel.

Figure 3: Benefit to Agriculture of Reviewed Projects



While many of these benefits are described in more detail in the project summaries *(Annex)*, some examples of BARD projects with important agricultural impacts include: the inhibition of chilling injury, delayed ripening techniques, the electronic sorting and grading of fruit; the optimization of environmental control for greenhouse crops, the development of new varieties of cut flowers through introduction of promising species from the *Brodiaea* complex, and optimized vine microclimate, crop yield and quality in table and wine grapes.

BARD has invested in the environment through projects on the use of agricultural and municipal wastes for preparation of disease-suppressive composts, post-planting control of soilborne pathogens in fruit tree crops, soil solarization technology to replace the use of methyl bromide.

Genetics and improved breeding are included in BARD-supported work on molecular approaches to strain improvement and determination of the role of specific gene products, in biocontrol by *Trichoderma spp.* and production of antibodies to citrus tristeza viruses.

Other BARD projects with agricultural impacts include postharvest improvements that reduce decay and extend shelf life of harvested fruit, automation of greenhouse management, increased efficiency in poultry and channel catfish production. In the area of soil science, BARD's contributions to the area of drip irrigation and modeling of water movement in the soil has been most significant.

3.3. Economic Impact - Outputs

Because most BARD projects are of a basic or strategic nature, a relatively small proportion of the 520 completed projects examined provided evidence of economic return, thus expectations for direct commercial success from BARD projects are not high. Nevertheless, BARD research has significantly impacted specific industries in each country. The economic report stressed the importance of BARD's support in contributing to long term goals and the success of subsequent work by the PIs, and by others, who build entire programs on the foundations that were created by BARD funding.

As part of this review a consortium of US and Israeli agricultural economists was commissioned to assess a group of projects whose results have a high potential economic impact. To select the projects evaluated,

some 500 BARD projects were first screened for potential commercial impacts. Those with the most promising and potentially measurable economic returns were selected for further evaluation. Following this, the BARD management conducted a round of screening, reducing the project pool to 60. Subsequent discussions between BARD staff and the US and Israeli economic evaluation team reduced this set of projects to 25 and finally to 10. Those 10 projects were subjected to detailed quantitative evaluation. Information was gathered from project scientists, non-project scientists and representatives of relevant industries. Cost-benefit anaylses were conducted. For the projects analyzed, it was clear that parallel funding from other sources contributed to the outcomes, but in some cases, it was not possible to decide explicitly what proportion of the total outcome could be attributed to BARD. This figure was estimated, where necessary, based upon the best information available.

The economic survey concluded that the ten projects evaluated are already producing benefits to Israel, the United States, or both countries. The report projects that aggregate benefits of these projects alone (nearly $736M for both countries by the year 2010, Table 1) exceed the total expenditures of BARD ($186M) since its inception 20 years ago. If the benefits from the five projects evaluated in the Ten Year External Review are included, the outcomes of 15 projects greatly exceed the discounted value of the investment in BARD. No doubt, many of the remaining 835 projects funded by BARD have or will also generate economic benefits. Therefore, it is reasonable to assume that the total economic impacts of all projects can be estimated at being several times higher that the figure presented by the external economic review pertaining only to the 10 selected projects.

In addition, BARD finances a significant amount of postdoctoral training, graduate student support, international exchange and permanent equipment where calculations of direct economic benefits are virtually impossible but clearly must be substantial.

The aggregate benefits of the projects evaluated in the economic survey were seen to be nearly equally divided between the two countries, although certain projects disproportionately benefit one country or the other. Of the ten projects, the poultry feed restriction, catfish aeration, and Tilapia breeding projects are expected to be of particular value to the United States. All of the projects evaluated, with the exception of northern leaf blight

resistance in sweet corn and controlling soilborne pathogens with *Trichoderma*, are expected to generate significant benefits to Israel.

Three of the projects evaluated had outstanding economic outcomes: early feed restriction in poultry, selective breeding of Tilapia and improved aeration systems for channel catfish. In each case there were significant savings in production costs and high adoption rates to give expected benefits totaling $263M in 1998 alone, and $3.5B by 2010. BARD-sponsored research was critical for the success of each of these projects.

The estimates of future economic benefits of the ten projects evaluated in this report should be regarded as just that. As with any evaluation of future benefits, the analysis necessarily relied upon estimated forecasts regarding producer adoption rates of each technology, and the effects of each technology on production costs and expected yield. Nevertheless, by soliciting opinions from market experts, producers, external scientists, and the project scientists themselves, the estimated benefits are based on a collective impression of the potential impacts of the technology. As such, they provide a reasonable basis for public policy discussions regarding the economic merits of BARD.

4. Collaboration in BARD Research

An essential part of the philosophy of BARD in joining agricultural scientists from the two countries in common scientific pursuit is that, through the synergies, complementarities and the mutual support engendered, outputs and outcomes will be delivered that are not possible if the scientists work separately.

The potency of BARD collaboration is illustrated by some of the superb outcomes from this type of research. The strong connections that are built show themselves in ways that continue beyond the lifetime of the grant and include the integration of multidisciplinary research, exchange visits to Israel or the United States, combined fundamental expertise to solve practical problems, better understanding of the two cultures, and more. Collaboration is stimulating and positive even when not funded. Long-term relationships are fostered and communications are improved; just jointly writing the application increases the information exchange.

Table 1: Summary of the Results of the Economic Evaluation
(through 2010, in million US $)

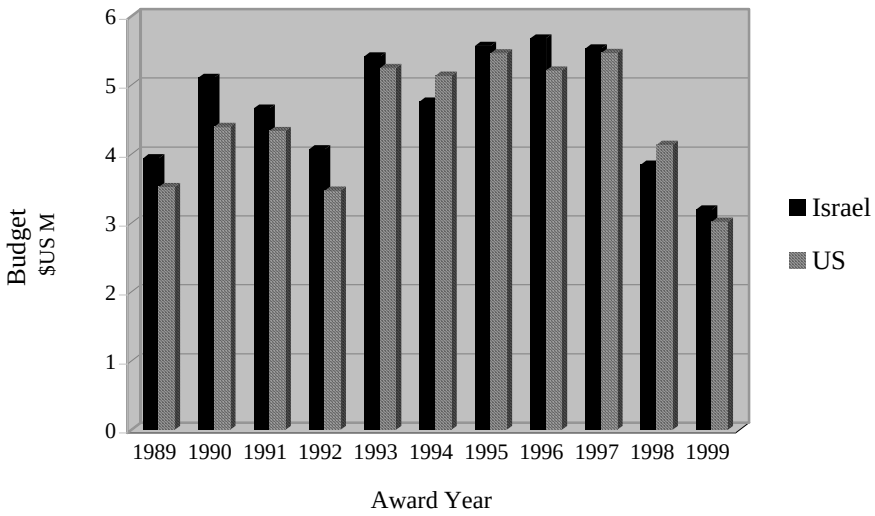
Project Title	US Benefits	Israel Benefits
Growth Stimulation and Improved Feed Efficiency by Feed Restrictions in Chickens and Turkeys	187	16
Knowledge-Based Information Systems for Dairy Herd Management	0.7	30.6
Optimization of Chromosome Set and Sex Manipulations in Common Carp, *Cyprinus Carpio* L.	Negligible	7.9
Aeration and Stirring of Intensive Aquaculture Systems	150	3.1
Determination of Carotenoids and Capscaicinoids in Chile Peppers and Paprika: Genetic, Physiological and Horticultural Aspects	Low	47.3
Introgression of Resistance to Northern Leaf Blight into Sweet Corn with the Sugary Enhancer Gene: A Genetic and Epidemiological Study	1.0	0.5
Molecular Approaches to Strain Development and Determination of Role of Specific Gene Products in Biocontrol by *Trichoderma* spp.	Low	2.2
Tagging Plants with Tightly Linked RFLP Markers	Too early to tell	33.2
Development and Testing of a Method for the Systematic Discovery and Utilization of Novel QTLs in the Production of Improved Crop Varieties: Tomato as a Model System	1.2	158.5
Selective Breeding of Farmed Fish	95.8	Not evaluated
Total	**436**	**300**

5. BARD Operations

5.1 Collaborative Research Projects

The core of BARD's activities is the support of collaborative research projects. Submissions for projects of three-year's duration are called for annually with a closing date of September 1. Decisions are announced in the following spring. BARD has funded 22 rounds of submissions in the period 1979–1999, with two rounds each in 1979 and 1980 and annual submissions since then. In the 22 submissions to June 1998, some 3,000 proposals were received and of these, 850 were funded with a total budgetary commitment of $186M. *Table 2* (page 47) shows how this budget was divided between the partner countries and research areas in the period 1989–1999. The allocation of the research budget by country of research from 1989 through 1999 is shown in *Figure 4*. During the last 10 years, the distribution of the funds is approaching 50% for each country. BARD has no policy dictating how the budget will be allocated; the collaborating partners determine this and there is a nearly equal distribution of funds between the US and the Israeli participating laboratories.

Figure 4: Allocation of Research Budget by Country of Research



5.1.1 Proposal Evaluation and Selection Process

Review Panels

Proposals, prepared jointly by US and Israeli scientists are reviewed separately in each country. Review panels, one for each project area in each country, evaluate the scientific merit, probability of success, benefit to agriculture in their own country, quality of collaboration and the budgetary request of each proposal. The chairperson of each country's project-area panel prepares an ordered list of potential reviewers. BARD staff send the proposal abstract to six reviewers, as named by the chairs of the review panels with an invitation to review. Since 1998, both panels see the same reviews.

In both countries, the proposals in a given area are divided amongst panel members according to their specific expertise. Those members summarize the *ad hoc* reviews prior to the full panel's discussion leading to a final consensus and recommendation for each proposal. The panels, working with the *ad hoc* reviewers' scores and recommendations, meet to discuss the relative rankings of the proposals independently in each of the eleven panels in Israel and the United States. Recommendations regarding funding and relative priority rankings are made by each of the eleven panels in Israel and the United States, through their chairpersons.

The final written summary and recommendations from each panel chairperson in each country are forwarded to TAC for consideration. These include a brief description of the proposal objectives, its strengths and weaknesses, and a concise recommendation regarding funding. Numerical scores are provided for the four selection parameters including an overall support recommendation score and priority ranking within the panel.

Israeli panels and their chairs are appointed by the Executive Director, in consultation with the Chief Scientist of the Ministry of Agriculture. Likewise, US panels and their chairs are appointed by the Executive Director, in consultation with the ARS Administrator. Previous and current panel chairpersons in Israel and the United States (1988-2000) are listed in *List 1* (page 56).

Technical Advisory Committee (TAC)
TAC consists of ten senior scientists, five from each country. The Executive Director, in consultation with the Board of Directors, appoints members of TAC. The term of office of TAC members is three years, staggered in such a way as to maintain representation in each major subject area. A list of TAC members, 1988-2000, is to be found in *List 2* (page 59).

The primary function of TAC is to prioritize the proposals recommended for funding by Israeli and US panels. To perform this function, TAC divides into three sub-committees, each dealing, as a group, with one-third of the proposals. The members of the sub-committees are deliberately chosen from TAC members who are not specialized in the subject areas. Upon completion of the first prioritization, the entire TAC meets to decide final rankings and recommendations. Projects with disparate priority ranking by the US and Israeli panels may be assigned to a TAC member with expertise in the subject area of the project who can provide information for a more complete consideration by the full TAC. The number of projects on the final list is determined by the budget available, as communicated by the Executive Director.

TAC also has a formal role in assessing and selecting applicants for BARD's fellowship and workshop programs and an informal role in making suggestions for improving BARD's operations. TAC monitors procedures for assessing proposals, reading and evaluating final scientific reports, identifying funding priorities for new areas of research, reassessing existing areas of research with complementary priorities in the US and Israel, suggesting topics for workshops, and providing general technical advice to the Executive Director.

Efficiency and Effectiveness of the Selection Process
The current procedure for project evaluation and ranking involves peer and panel review in each country, followed by TAC deliberations. This two-tiered procedure, where the first tier is further divided to separately represent the two countries, has survived in principle over the 20 years of BARD's operation, although there have been some significant changes in operational detail of the peer and panel process and this evolution is continuing. These changes include, for example, the use of common peer reviewers by Israeli and US panels starting in 1998, changes in eligibility for PIs and Co-PIs, (1999), strengthening the collaborative requirements,

modification of final reporting, etc.

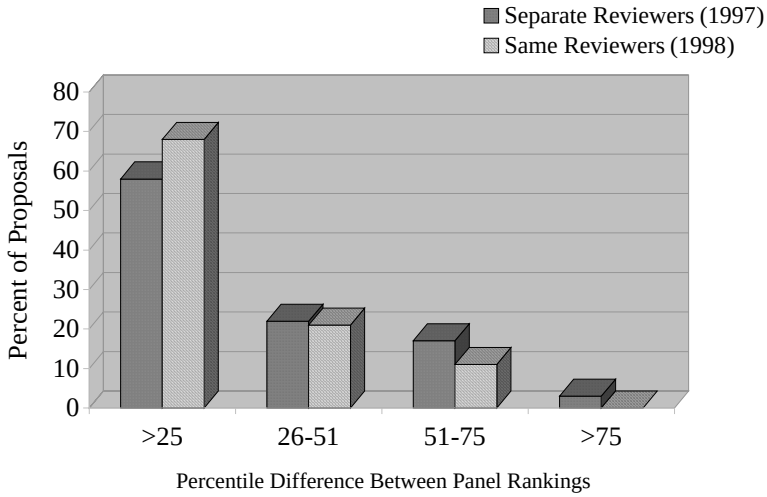
The Committee believes that the criteria in use for selection of the most fundable projects are sound and the recent stronger emphasis on 'potential for fruitful collaboration' is appropriate.

Recommendation 1: That the selection of fundable proposals continue to be based on–scientific merit, benefit to agriculture of both countries, potential of fruitful collaboration between US and Israeli investigators and probability of success within the lifetime of the project.

There is, on the whole, agreement amongst BARD's clients and those who have served in the selection process that it selects the best proposals for funding with a high degree of integrity and fairness. Nonetheless, the review Committee also heard opinions and comments about several aspects of the project selection process. These included the need for TAC, the panel structure and number of members, the panel designations, rigor of the scientific evaluation and discussion in panels, perceived 'super evaluation' by large Israeli panels, the disconnection between panels, the confidentiality of the process, the lack of communication between panel chairs and TAC, the availability of reviewer's names to panels, the panel operation in the US, the selection of reviewers, the weight of panel input versus reviewer input, and input from the Israeli government through the Chief Scientist. The scientific and economic evaluations indicate that, in a few instances, proposals had not been selected carefully enough against the guidelines concerning choice of problems of mutual interest and demonstrable collaboration.

Prior to 1998, panels in the US and Israel worked with separate ad hoc reviewers. In 1998, BARD introduced a policy change in which the two panels, while continuing to select ad hoc reviewers independently, made their recommendations based on *all* ad hoc reviewers. As shown in *Figure 5*, this policy increased the agreement rate in 1998 and this trend has continued.

Figure 5: Comparison of Panel Agreement



The Committee received a number of detailed proposals for amendments to the evaluation and selection procedures. These included modification of the two-panel system, reduction of the number of panels, modification of TAC membership (including that panel chairs become TAC) and evaluation solely by a TAC. Other proposals favored maintenance of the *status quo*. The Committee noted that, although the two-tiered selection system has been retained in principle, the process has evolved during the life of BARD.

Recommendation 2: Whereas the Committee endorses the two-tiered system (subject panels and TAC), there are a number of possible modifications that may increase the efficiency of the evaluation and selection process. The Committee therefore recommends that the Board of Directors, in consultation with TAC and the Executive Director, seriously consider options for modification of the current procedures.

The Committee was concerned to note that among the 240 scientists serving on the eleven panels only 21 are women. While taking into account the availability of qualified women scientists in the agricultural research communities of the United States and Israel, the Committee believes that the Executive Director, the Board of Directors and TAC should address this apparent gender imbalance when making future appointments to the panels and TAC.

Recommendation 3: That BARD takes steps to redress the marked gender imbalance in the review panels and TAC.

Eligibility Rules

During the course of the review, the question of eligibility of PIs, Co-PIs and serving TAC and panel members to apply for BARD funding was discussed. It was noted that at the 1999 Board of Directors meeting eligibility policy was changed so that no more than one application from the same investigator in a given year will be considered and the same investigator will not be funded in more than one concurrent project. These changes in eligibility for PIs and co-PI's instituted in 1999 represent a significant departure from past practice. The committee endorses these changes in the eligibility rules.

5.1.2 Retrospective Project Evaluation

From its inception, BARD has followed a process of retrospective project evaluation. Before final quarter payments are made, the PI must submit a report on the progress of the three-year project. This report is sent for peer evaluation. The Committee endorses this practice and notes that, without the reports and reviews, BARD cannot properly assess the success of its research program. The final reports will continue to provide an important means for judging the effectiveness of research supported by BARD and will be invaluable to the continued assessment of the scientific outcomes and outputs of the research.

The Committee found that the final reports were overly long. It was also noted that the timing of receipt of the final report is usually too early to allow recording of the true outputs and outcomes of the project. This was borne out by an inspection of supplementary reports from completed projects that were assessed for scientific merit. Annual updating of outcomes and outputs arising from projects would keep the database current.

Recommendation 4: That the body of the final report be limited to three pages plus a list of published, accepted and submitted manuscript, abstract and details of M.Sc. and Ph.D theses arising from the project.

Recommendation 5: That BARD annually requests previous grant holders to provide information about publications, patents and application of research findings arising from their completed projects.

The Committee believes that it would be more useful if TAC members reviewed the final reports. This would also provide TAC with an indication of the success or otherwise of previously supported projects.

Recommendation 6: That procedure for peer review of final reports is modified and that TAC is involved in the process.

5.1.3 Approval Rate of Submissions

The annual rate of support as a percentage of total proposals submitted *(Table 3*, page 48*)* shows an average approval rate of *27%* over the 22 submission rounds. The average approval rate for the years 1989-1999 was *23.7%*, whereas the approval rate in 1999 fell to an even lower *20%*. The average number of proposals submitted annually in the period 1989-1998 was 151, but the actual number of proposals submitted has declined from a high of 182 in 1989 to a low of 125 in 1998.

The approved expenditure, by budget item, in BARD grants in the two countries is shown in *Table 4* (page 49). The largest proportion, *51%*, is allocated to salaries and, together with supplies, *23.1%*, and overhead, *17.5%*, accounts for *91.6%* of the budget. The remainder is allocated between travel, *3%*, and non-expendable equipment, *5.4%*.

5.1.4 Agricultural Research Areas Funded

Table 5 (page 49) classifies the projects submitted and those approved, by research area. Plant Protection accounts for the largest proportion of the budget, *18.8%*, and Agricultural Economics the smallest, *1.7%*. The section on Cellular and Molecular Biology in Agriculture, introduced in 1985, now has a *12.8%* share, reflecting its perceived importance in supporting advances in agricultural production. The allocation of funds to each sector in Israel and the United States are shown in greater detail for the years 1989-1999 in *Table 2* (page 47).

5.1.5 Institutions Funded

The institutions participating in BARD in the United States 1979-1999 are listed in *List 3* (page 60). Forty seven States, plus Puerto Rico and the District of Columbia, have received BARD grants, i.e., every state except Alaska and North and South Dakota. (North Dakota has submitted proposals, but has not received an award). Seventy seven percent of the total distribution of BARD funds in the United States has gone to Land Grant universities and *15%* to ARS (182 projects in 28 states as shown in *List 4*,

page 64). The University of California continues to be the largest single recipient *(16.7%*) of BARD funding in the United States (UC-Davis – *10%*, UC-Riverside – *4.7%*). Cornell University (*7.6%*), the University of Florida (*6%*), and Texas A&M (*4.7%*) (all of Texas totals *5.6%)* are the leaders among other recipients, together with Purdue University (*3.2%*). Land Grant universities in Michigan, Virginia, Pennsylvania, Iowa, Wisconsin, Washington, Utah, South Carolina, Ohio, North Carolina, New Jersey, Nebraska, Minnesota, Illinois, Arizona and Alabama have all received substantial portions of the BARD allocations *(List 3*, page 60*)*.

List 5 (page 65) shows comparable data for Israel. The Ministry of Agriculture and Rural Development's Agriculture Research Organization received just under half, (*49.3%*), of the total allocation of BARD funds in Israel. The Hebrew University of Jerusalem received *22.8%*. Other major recipients include the Veterinary Services (*6.2%*), Tel Aviv University (*5.3%*), Technion (*4.4%*), Weizmann Institute of Science, (*4.4%*) and the Oceanographic Institute (*2.5%*).

5.1.6 Project Administrative Process

No formal assessment of BARD's administration was attempted. However, discussions with university, ARO and USDA administrative staff and the responses from grant holders via the internet, including some from unsuccessful applicants, suggest that no major problems have been encountered. Grant holders and administrators are generally very well satisfied with the grant handling process and the prompt and responsive attention to their queries. The BARD administrative team is to be commended for the effectiveness and efficiency of its handling of the day-to-day operations.

During the period under review, there were a number of modifications to the project administrative process. BARD's offices at Bet Dagan are now well equipped for electronic handling of submissions and accounts, and this has made for increased efficiency in communication. Currently, many grant operations are transacted through the internet. Guidelines and application forms are available on-line and abstracts are submitted electronically. A 'secure' system has been introduced to send reviews electronically to panel members and TAC. It is proposed to introduce on-line submission of scientific and fiscal reports and the extension of this mechanism to distribution of proposals to reviewers and panel members is foreshadowed.

To date, on-line submission of proposals has not been attempted, although electronic cover pages and abstracts have been required for the past two years. These continuing developments are to be commended.

5.2 Type and Scope of Research

BARD does not issue guidelines on the type of research to be supported, but inspection of the portfolio of projects suggests that more than *80%* may be classified as basic or strategic (mission oriented) research and the remainder as applied research.

The implementation of competitive grants programs such as BARD and the USDA's Competitive Research Grants Office starting in 1978, permanently changed the way agricultural research is funded in the United States and Israel. Prior to these programs, agricultural research in these two countries was funded almost entirely by so-called "hard funds", which included all operating funds as well as salaries and facilities for each program. Today, the "hard funds" pay for infrastructure, which still includes salaries of the researchers and some of their support staff, facilities, most of the larger items of equipment, and usually some, but rarely all, of the base (operating) funds. Beyond this, agricultural scientists must compete for the funds required to operate their programs. Competitive grants are rarely or never adequate nor are they intended to pay for salaries of permanent scientists and support staff, facilities or large items of equipment. Rather, competitive grants allow creative scientists to expand their capacity as researchers, often by hiring a postdoctoral associate or graduate student to follow up on an idea of particular scientific significance.

Because competitive grants are typically short-term, e.g., one, two, or three years, the more successful researchers build their programs (and their careers) on multiple, scientifically complementary and sequentially overlapping grants. For this reason, giving credit for a particular scientific breakthrough can become quite complex. For example, the cloning by Cornell University scientists of the PTO gene from tomato for resistance to *Pseudomonas syringae* pv. *tomato* was a major scientific breakthrough reported as a cover article in *Science* in 1993. Both a USDA NRI grant from the Genome program and a BARD grant funded the work, and the senior author of the report was an NSF postdoctoral fellow. In addition to these credits, probably the greatest financial commitment was the investment by the state of New York in infrastructure at Cornell required for this research.

Nevertheless, the multiple sources of competitive grants and postdoctoral support brought a new mix of young and senior investigators together, including those from the United States and Israel because of the BARD support. That could not have happened under the old way of supporting agricultural research. Furthermore, the need to prepare a competitive proposal and the feedback from the peer review has the advantage of elevating the quality and productivity of the entire agricultural research enterprise, and not just that portion funded by grants.

5.2.1 Balance Between Types of Research and Areas of Research Funded

It is important that BARD maintain control over the balance of the types of research and the areas of research that are being funded. BARD needs to be flexible in the interpretation of its mandate. It has been argued by some, that BARD is funding too many basic projects for the size of its budget. It is important to distinguish between pure basic research and strategic-basic research that has an eventual practical goal, i.e., is mission-oriented. BARD should, and does, fund many projects with this strategic-basic approach as well as pre-commercial, applied research. Other US-Israel collaborative funds are available for both purely basic research (BSF: the Binational Science Foundation) and for commercial development projects (BIRD: the Binational Industrial Research and Development Fund). The Committee estimates that some *20%* of BARD-funded projects are directed towards applied research and development, most of which do contain an element of strategic research. Approximately *10%* of BARD's portfolio can be classified as basic research. The remainder of the BARD portfolio (*70%*) is mission-oriented (strategic) research. The Committee considers these proportions to be appropriate to the defined mission of BARD.

During the Fund's 20 years of existence, by far the largest allocation of resources has been in the biological sciences underpinning agriculture (*82%*). During this time there has been a burgeoning in the biological sciences related to agriculture and the promise of the application of molecular genetic technology to the improved resistance of crop species to environmental and disease threats, as well as the improved quality of agricultural and horticultural produce. BARD has responded to the promise of these newer developments and supported many proposals in these areas.

On the other hand, there are relatively few allocations to many other areas of agriculture that are listed in the ‘Scope of Cooperation’ schedule in the

original agreement. Thus water conservation, water management and utilization, soil management, utilization of new forms of energy for agricultural production, environmental aspects of agricultural technology, intensive crop production, agricultural engineering and processing and other aspects of agricultural technology are poorly represented. These lower allocations, of course, reflect the smaller number of submissions in these particular areas. (*Table 5*, page 49).

Agricultural engineers have made an impressive contribution with a small proportion of BARD funds (*6.3%* of the total BARD funds allocated in both countries). Their systems approach to agriculture, as opposed to the component approach, provides a significant analytical tool in optimizing agricultural production. Soil conservation and water utilization research are national priorities in both countries, and BARD has provided some excellent examples of practical solutions from soil and water research. Nevertheless, water and soils research is relatively under-represented in the program (*9.4%* of the total funds allocated). There is an opportunity for regional synergism between the national initiatives for water research in the Middle East and BARD's program. It may be possible for BARD to put the right resources, at the right time, into this area.

Apart from these under-represented areas of R&D in some traditional sectors of agriculture, there are non-traditional sectors that have been introduced since the agreement was drawn up, including agricultural sustainability and the environment, food safety, aquaculture, biological resources and bioprocesses. BARD must continue to reflect the developments in agricultural and biological sciences and be sensitive to agriculture's major problems and opportunities as they evolve in the partner countries.

Although there is a need for research in these areas, it is not suggested that BARD earmark or give priorities to any particular agricultural area, as this could lead to a risk of supporting research of lower quality. Ideally, more high-quality proposals in the under-represented areas will be submitted for funding and as this happens, the BARD program is clearly poised to respond with funding.

5.3. Postdoctoral Fellowships

The objective of the Vaadia-BARD Postdoctoral Fellowship program, so

named to recognize and honor Professor Yoash Vaadia who, with T.W. Edminster, co-founded the Fund, is to enable younger agricultural scientists to acquire skills and techniques while becoming professionally established in the agricultural research community. The program promotes cooperative agricultural research between postdoctoral fellows from one country (the United States or Israel) and senior scientists from the other country.

Postdoctoral Fellowship awards commenced in 1985; there have been 296 applicants. Of these, 36 were US citizens 16 of whom accepted the awards offered. In the same period there were 260 Israeli applicants and 98 awards were made and accepted. Postdoctoral fellowships accounted for $218,000 (*2.9%* of the budget) in 1999 *(Table 6,* page 50*).*

It is regrettable that in the last decade very few US citizens (26 out of a total of 211) have applied to the program *(Table 7,* page 51*).* Notwithstanding this asymmetry, it is an outstanding program of very high quality, and has provided an opportunity for bright, well-prepared Israeli scientists to participate in US research projects. Its manpower contributes to the US agricultural research effort and at the same time, trains a new echelon of Israeli agricultural research workers. To that extent there is mutual benefit. *(List 6,* page 66*).*

Recommendation 7: That the award of the Vaadia-BARD Postdoctoral Fellowships continue.

5.4. Senior Research Fellowships

As a partial solution to the imbalance in the US/Israel postdoctoral fellowship numbers, Senior Research Fellowships were introduced in 1990. The objectives of this program are to promote cooperative agricultural research between fellows from the United States and scientists in Israel, to provide BARD with input into advanced research areas and to enhance scientific competence in these areas. The fellowships are available to citizens of the United States who are established research scientists affiliated with a US non-profit research institution, university, federal or state agency who wish to spend from three to twelve months in an Israeli laboratory pursuing an approved agricultural research project. To date, five have been awarded. Their names and affiliations are shown in *Table 8* (page 52).

The introduction of the Senior Fellowship program is a worthwhile

innovation. In addition to the research project model, BARD should consider supporting US fellows for shorter periods in Israel. This would provide an opportunity to develop a research proposal with an Israeli scientist, or could support an intensive round of lectures, workshops, consultations, seminars, discussions, visits, or other business.

Recommendation 8: That the Senior Research Fellowship program continues in its present form, but its scope is widened and the minimum period of tenure is reduced to one month.

5.5. Workshops

During the last decade, BARD has continued to foster exchanges of ideas and expertise in areas of developing agricultural science by supporting 16 workshops *(List 7,* page 69*)* in the period of the review. Through these workshops, liaisons have been formed between participants from the United States and Israel that have led to successful proposals for BARD support. Participation by scientists from elsewhere has also been encouraged and delegates from Israel's Middle Eastern neighbors have been included. BARD policy is to fund independent or "stand alone" workshops on topics related specifically to the programmatic areas that make up BARD rather than sessions or components of larger meetings organized by other institutions or scientific entities. Reference to specific workshops is made in several of the project summaries.

Recommendation 9: Workshops should be funded as independent or "stand-alone" activities and under current guidelines for scope and selection criteria. The mode of publication of the proceedings should remain optional, depending upon the workshop.

6. Funding BARD's Activities

6.1. Sources of the Research Budget

The source of BARD's research budget is the interest on the endowment fund. This fund, established under the original agreement between the United States and Israeli Governments, consists of $40 million from each country and attracts a fixed interest of *7% per annum*, paid quarterly, in arrears, i.e. $5.6M *per annum*.

The endowment fund was augmented in 1984 by $15M from each country. The interest on this amount is calculated according to a formula based on changes in the London Interbank Offering Rate and is paid half-yearly. Since 1984, this interest rate has fluctuated between 6% and 10.5% per annum and currently (1999) is 7% per annum. The income from this part of the endowment fund has averaged $2.25M per annum *(Figure 6).* In 1994 an agreement was reached that Israel would match any US supplement up to the amount of $2.5M annually. *Figure 7* shows the actual amount of the supplements received.

Figure 6: Interest Rates for Endowment and Cash Reserves

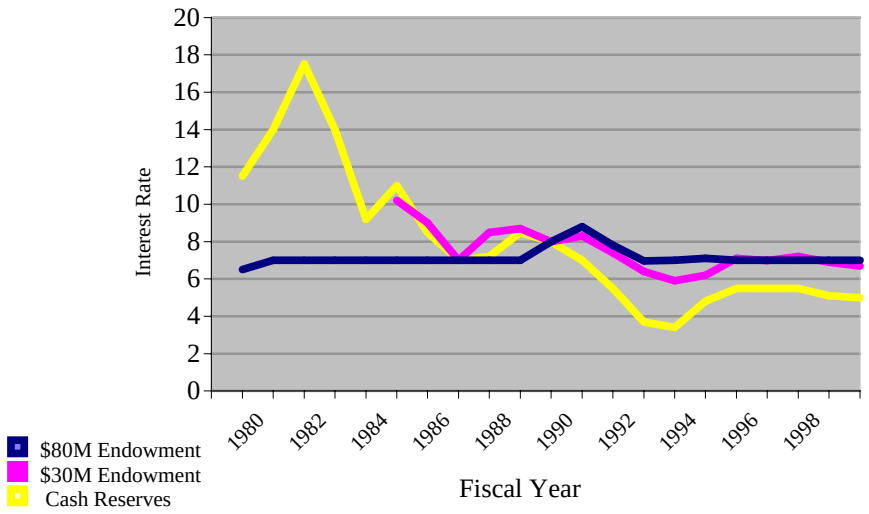
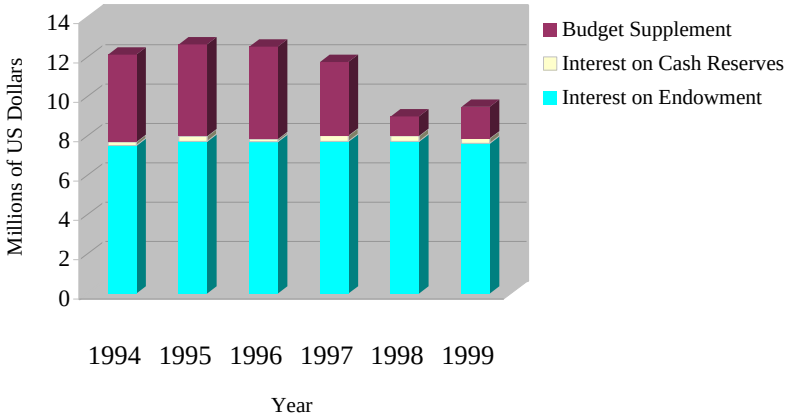


Figure 7: BARD Income (1994-1999)



After deducting operating expenses (not exceeding *8%*) the total income is used entirely to support research projects, postdoctoral and senior fellowships and workshops. The actual commitments according to budget years throughout the life time of BARD are shown in *Table 9*, (page 53) expressed in US dollars, based on balance sheet figures and including research grants, postdoctoral and senior research fellowships, and workshops and after deduction of unexpended allocations.

Figure 8: Change in Purchasing Power of the Dollar in Israel and the US (1978-1999)

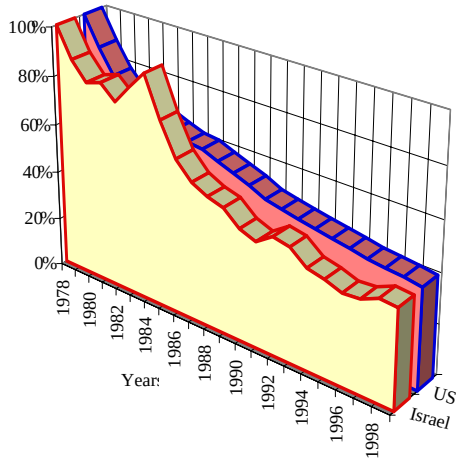


Table 10 (page 54) presents the impact of US dollar devaluation on the research budgets. The decrease in the purchasing power of the US dollar in the United States and in Israel during the lifetime of BARD is shown in *Figure 8*. The decline in approval rate of proposal submission rounds parallels the decrease in the value of the US dollar.

6.2. Future Funding

The Board of Directors and successive Executive Directors have worked hard to maintain the purchasing power of the research budget at 1979 levels by successfully negotiating an increase in the size of the endowment fund in 1984 and by obtaining supplementary funds since 1994. However, the recent difficulties encountered in maintaining the size of the supplementary funds has brought BARD to a situation where there is an urgent need to seek a solution to this now chronic budgetary problem.

Without the supplements, BARD has a fixed annual income of approximately $7.9M. Over the years since 1979, the purchasing power of this fixed income has declined by *59%*. This means that, without the budget supplement, BARD would be able to fund only 23 projects at the level of $300,000 ($50,000 per year, per partner country) each, plus a modest number of postdoctoral, senior fellowships and workshops.

There is continuing pressure from the community of agricultural researchers in both the US and Israel for support for meritorious projects in agricultural research, and BARD has the administrative capacity to handle as many projects (43) as it did in 1989.

BARD should aim to have disposable funds to allow funding of approximately 40 new projects per year at an average annual funding level of $55,000 for each partner, i.e., $14.5M dollars per year to support the research grant program, other scientific activities and overhead. ($13.2M for research projects, $0.45M for postdoctoral fellows, $0.1M senior research fellows, $0.07M workshops and $0.8M for administrative costs amounts to $14.6M).

The relatively low per-project funding over the past few years, and the diminishing numbers of grants that can be funded, suggest that the minimum grant size should be increased. US scientists in particular, have expressed the view that the amount of support provided is not

commensurate with the effort expended in preparing applications and the 'tough' reporting requirements.

Recommendation 10: That the Board of Directors consider options and devise strategies for augmenting disposable funds to around $14.5M. This would allow the funding of 40 new projects per year at an average annual value of $55,000 for each partner, 8-10 fellowships as well as a workshop and the administrative overheads.

7. Operational Features

7.1. Governance and Administration

7.1.1 The Board of Directors

The Board of Directors consists of six members; three are citizens of the United States and three are citizens of Israel. The Board is responsible for the Fund's program and its financial and managerial policies. At its annual meeting, the Board approves the budget and the research portfolios, through consideration of the recommendations of TAC with respect to project funding, postdoctoral, senior fellowships and workshops. Its chairmanship rotates annually between a US and an Israeli member. The membership of the Board of Directors since 1979 is shown in *List 8* (page 70).

7.1.2 Operations and Administration

BARD has a main office in Bet Dagan, Israel, supervised by Dr. Edo Chalutz, the Executive Director who is responsible for the general overview and management of the entire BARD operation. A part time (85%) administrative assistant supports him. A Scientific Research Coordinator (full time) manages the project proposals and grant review process and administratively oversees projects throughout their life, with the help of an administrative assistant (full time). A Special Program Coordinator (full time) is responsible for public relations, special projects, international correspondence and assists in overseeing the proposal evaluation process.

The part time Controller (*70%*) is in charge of all financial transactions for BARD, and responsible for the fiscal management of projects, financial reporting and recording statistical data. A part time accountant (70%) and a part time secretary (50%) assist the Controller. BARD also maintains an office in the United States, staffed by an ARS Program Assistant.

As an indication of the workload of the BARD office, 107 projects were under management and 147 submissions were being evaluated in September 1996. The Committee noted that since 1997, the Israeli BARD staff was reduced from 8.75 positions to 6.5 positions. The reduction in staff has served to streamline the operations while offering members further responsibilities and satisfaction in their roles in the Fund.

BARD operational expenditures compared to income (1979-1999) are shown in *Table 6* (page 50). The relative costs of administration have risen as the budget has declined and BARD's current higher operational budget is due primarily to the lowered total income. In 1998 administrative costs were *7.8%* of the total income, up from *6.9%* in the 1987-88 budget, with an average of *6.6%* over the last 10 years. The 1998 figure is close to the *8%* ceiling set by the Board of Directors in 1981. Comparable figures for other competitive grant programs are *4%* for NRI, *6.5%* for NIH, *6.5%* for Rockefeller Foundation Food Security Program, and *5%* for NSF, however none of these programs are binational. It should also be noted that BARD operational expenditures include staff salaries, which is not the case with some of the other grant programs listed.

8. Publicity

There is no doubt that BARD is now well established and widely-recognized as a player in funding agricultural research and development in the two countries. The enthusiastic comments from almost all the respondents in both the US and Israel support this view. BARD obviously has a proportionally greater funding impact in Israel than in the US since there are fewer alternative sources for funding agricultural research in Israel than in the US.

With a modest amount of money, over a 20 year period, BARD can point to selective funding of outstanding agricultural research, performed by leading scientists, and to the training of some of the most promising young agricultural scientists in a well-defined but broad program that supports agriculture of mutual importance and relevance in the two countries. BARD does not set goals for organizations performing research but supports and assists them in reaching national goals. By accessing talented individuals, the program engages a wider group of scientists, beyond the existing core, to work on mutually important agricultural science programs in the two countries.

Notwithstanding the fact that BARD's budget for the support of agricultural research and development is divided almost equally between the US and Israel *(Figure 4)*, there is a persistent perception that BARD funding favors Israel. This is unjustified and should be countered in public relations exercises.

BARD communicates with the general public through its newsletter and its website. Both are important and their use should continue. The linking of the BARD website to professional societies would be a useful extension.

The Committee believes that BARD needs to extend its publicity and communications by strengthening the interactions between the Board of Directors and representatives of the agricultural community, administrators and policy makers involved in budget formulations, especially in the US, where BARD seems to have lost some visibility.

Recommendation 11: That BARD continue its efforts in publicity and communication of the philosophy and practice of BARD funding to consolidate its image, especially amongst administrators and budget formulators in both countries. The positive aspects of the collaborative funding should be emphasized and the incorrect negative perceptions of an imbalance of allocations between the partner countries countered.

Recommendation 12: That the Board of Directors commissions an article for publication in a widely read journal describing the goals and successes of BARD.

9. Future External Reviews

The regular overviews of BARD by independent assessors have proven useful to the Board of Directors and Executive Directors in making appropriate adjustments to BARD's operations and its direction and scope.

Recommendation 13: That an independent "mini" review of BARD's operations takes place in 2004.

Acknowledgement

The Committee acknowledges the valuable assistance given by all BARD staff in Israel and the United States in providing background information during the evaluation process. We would, in particular, like to sincerely thank Mary Schweitzer who served as Secretary to the Committee for her organization of the review and for her untiring support in recording and transmitting the transactions of Committee meetings and interviews and in preparing the final report. Miriam Green (Controller), Haim Katz (Scientific Research Coordinator) and Noam Seligman provided the background analysis of BARD's operations included in the report. Throughout the review, Edo Chalutz (Executive Director) provided a source of information on BARD's operations and practical assistance in the Committee's activities. We also thank all those who contributed their ideas and assessments for our consideration.

Table 1:
Summary of the Results of the Economic Evaluation (page 25).

Table 2:
Approved Budget, by Research Area and Country, 1989-1999
(in thousands of US dollars)

Research Area	Israel		USA		Total Approved	
	Budget	%of Total	Budget	% of Total	Budget	% of Total
Ag. Economics	631	1.13	758	1.43	1,389	1.28
Ag. Engineering	3,179	5.67	3,276	6.20	6,455	5.93
Animal Production	6,391	11.40	5,639	10.66	12,030	11.04
Animal Protection	4,163	7.43	4,231	8.00	8,394	7.71
Aquaculture	3,038	5.42	2,837	5.37	5,875	5.39
Cell. & Mol. Biol. in Ag.	9,124	16.28	7,558	14.29	16,682	15.32
Field & Garden Crops	7,327	13.07	7,068	13.37	14,395	13.22
Fruit Tree Crops	2,711	4.84	2,732	5.17	5,443	5.00
Plant Protection	10,237	18.27	10,100	19.10	20,337	18.67
Postharv. & Food Science	4,834	8.63	4,498	8.51	9,332	8.57
Soil, Water, Air & Environ.	4,408	7.87	4,182	7.91	8,590	7.89
Total	**56,043**	**100**	**52,879**	**100**	**108,922**	**100**

ble 3:
mmary of Proposal Approval Rates, 1979-1999

Award Year	Number of Proposals		% Approved
	Submitted	Approved	
1980	163	78	48
1981	219	87	40
1982	128	42	33
1983	158	38	24
1984	133	38	29
1985	154	47	31
1986	165	45	27
1987	187	42	22
1988	180	40	22
1989	178	36	20
1990	182	43	24
1991	145	39	27
1992	165	36	22
1993	152	42	28
1994	119	34	29
1995	153	38	25
1996	157	35	22
1997	147	36	24
1998	143	29	20
1999	125	25	20
Total	**3,153**	**850**	**27**

Table 3

Table 4:
Approved Expenditures, by Budget Item, 1979-1999

Budget Item	Salaries	Equip.	Supplies	Travel Abroad	Overhead	Total
ISRAEL	46,443,205	7,016,436	24,645,349	2,943,250	17,455,285	**98,503,525**
% of total	47.1	7.1	25.0	3.0	17.7	**100**
US	45,651,378	2,565,785	17,186,573	2,432,469	13,969,171	**81,805,376**
% of total	55.8	3.1	21.0	3.0	17.1	**100**
TOTAL	**92,094,583**	**9,582,221**	**41,831,922**	**5,375,719**	**31,424,456**	**180,308,901**
% of total	51.1	5.3	23.2	3.0	17.4	**100**

Table 5:
Project Approval Rate by Research Area, 1979-1999

Area of Research	Number of Projects			Approved Budget (In thousands of US dollars)			
	Submitted	Approved	%	Israel	US	Total	% of Total
Agricultural Economics	90	28	31	1,678	1,347	3,025	1.7
Agricultural Engineering	186	50	27	5,814	5,456	11,270	6.3
Animal Production	297	82	28	11,167	8,051	19,218	10.7
Animal Protection	243	67	28	7,921	6,308	14,229	7.9
Aquaculture	163	46	28	5,646	4,350	9,996	5.5
Cell. & Mol. Biol. in Ag.	380	103	27	13,123	10,032	23,155	12.8
Field & Garden Crops	415	103	25	11,757	10,206	21,963	12.2
Fruit Tree Crops	178	53	30	6,067	4,984	11,051	6.1
Plant Protection	590	157	27	17,697	16,147	33,844	18.8
Postharv. & Food Science	281	75	27	8,575	7,012	15,587	8.6
Soil, Water, Air and Environ.	330	86	26	9,058	7,913	16,971	9.4
Total	**3,153**	**850**	**27**	**98,503**	**81,806**	**180,309**	**100**

Table 6:
Summary of Annual Expenditures, 1979-1999, (Thousands of US $)

Award Year	Fiscal Year	Research Projects	Work-shop[1]	Feasib. Study[2]	Postdoc Fellow[3]	Research Fellow[4]	Special Projects[5]	Operating Budget	Total Budget
80	10/78-9/79	7,369		-			-	173	7,542
80	10/79-9/80	3,991		-			-	300	4,291
81	10/80-9/81	6,202		-			-	300	6,502
81	10/81-9/82	8,149		118			-	400	8,667
82	10/82-3/83 (6 mths.)	6,964		81			-	245	7,290
83	4/83-3/84	6,470	23	87			-	494	7,074
84	4/84-3/85	7,238	-	148			-	497	7,883
85	4/85-3/86	9,170	-	59			-	512	9,741
86	4/86-3/87	7,860	36	57	241		-	495	8,689
87	4/87-3/88	7,970	34		268		200	505	8,977
88	4/88-3/89	7,709	50		267		55	528	8,609
89	4/89-3/90	7,463	-		222		-	610	8,295
90	4/90-3/91	9,505	-		237		-	595	10,337
91	4/91-3/92	9,000	60		227	25	-	643	9,955
92	4/92-3/93	7,545	95		209	-	--	685	8,534
93	4/93-3/94	10,666	10		258	-	-	670	11,604
94	4/94-3/95	9,903	-		298	9	-	655	10,865
95	4/95-3/96	11,034	60		341	9	-	810	12,254
96	4/96-3/97	10,896	-		392	-	-	830	12,118
97	4-12/97 (9 mo.)	11,000	44		362	-	-	649	12,055
98	1-12/98	7,985	70		339	17	100	750	9,261
99	1-12/99	6,220	35		218	27	125	785	7,410
Total		**180,309**	**517**	**550**	**3,879**	**87**	**480**	**12,131**	**197,953**

[1] Workshops were initiated in 1982
[2] Feasibility Study become part of the regular research budget in 1985
[3] Postdoctoral Fellowships were initiated in 1985
[4] Research Fellowships were initiated in 1990
[5] Special Projects includes funding for External Reviews, Publications, etc.

Table 6

Table 7:
Postdoctoral Fellows, Applicants and Recipients, 1985-1999

Year	Number of Applicants			Number of Recipients		
	US	Israel	Total	US	Israel	Total
1985	5	25	30	2	9	**11**
1986	1	21	22	1	7	**8**
1987	4	23	27	2	7	**9**
1988	2	17	19	2	4	**6**
1989	1	21	22	0	6	**6**
1990	3	15	18	1	6	**7**
1992	2	12	14	1	4	**5**
1993	3	17	20	1	6	**7**
1994	5	23	28	1	6	**7**
1995	7	18	25	3	7	**10**
1996	1	16	17	0	9	**9**
1997	2	20	22	2	7	**9**
1998	0	15	15	0	8	**8**
1999	0	13	13	0	4	**4**
Totals	**36**	**256**	**292**	**16**	**90**	**106**

In 1991 the submission date for Postdoctoral Fellowship applications was changed from December 15 to January 15, thus, there were no applicants in 1991.

Table 8:
Senior Research Fellows, Applicants and Recipients, 1990-1999

Year	Number of Applicants	Number Funded	Award	Duration
1990	**2**	1	$25,000	**12 months**
1992	**2**	0		
1993	**1**	1	$9,000	**3 months**
1994	**1**	1	$9,000	**3 months**
1995	**1**	0		
1996	**0**	0		
1997	**2**	0		
1998	**1**	1	$16,500	**9 months**
1999	**2**	1	$27,000	**9 months**
Totals	**12**	**5**		

In 1991 the submission date for Fellowship applicants changed from December15 to January 15; thus, there were no applicants in 1991.

BARD Senior Research Fellows and their hosts in Israel.

Citovsky, Vitaly — State University of New York at Stony Brook: *Crystallographic Analysis of Agrobacterium VirD2 and VirE2 Proteins Involved in T-DNA Nuclear Import*, Host: Oded Livnah, The Hebrew University, Jerusalem

Raboy, Victor — USDA, ARS, Aberdeen Idaho: *Mutation Genetics Approaches to Maize Improvement*, Host: Joseph Hirshenhorn, ARO, Neve Yaar

Ringo, John M. — University of Maine: *Genetics of Organophosphate Resistance in Drosophila*; Host: Ephraim Cohen, The Hebrew University, Rehovot

Sinclair, Thomas R. — USDA, ARS & University of Florida: *Simple Process Model for Wheat Growth and Yield to Include Extreme Environmental Conditions*; Host: Yacob Amir, ARO, Gilat

Bendheim, Paul E. — New York State Institute for Basic Research: *Production of Transgenic Sheep Resistant to Scrapie*; Host: Irith Ginzburg, Weizmann Institute of Science, Rehovot

Table 8

Table 9:
Statement of Income, Grant Commitments and Payments, 1978-1999
(in US dollars)

Fiscal Year	Income Less Operating Expenses	Grant Commitments	Cumulative Balance	Payments
10/78 - 9/79	4,704,280	**1,359,197**	3,345,083	0
10/79 - 9/80	5,777,638	**2,271,810**	6,850,911	1,908,379
10/80 - 9/81	6,469,685	**6,102,249**	7,218,347	4,179,436
10/81 - 9/82	6,697,873	**8,943,728**	4,972,492	7,062,554
10/82 - 3/83 (6 mths.)	3,154,842	**7,041,221**	1,086,113	3,993,865
4/83 - 3/84	5,878,478	**7,228,948**	-264,357	6,511,123
4/84 - 3/85	7,242,598	**6,791,132**	187,109	8,459,996
4/85 - 3/86	8,490,112	**8,078,913**	598,308	7,482,379
4/86 - 3/87	7,863,660	**8,326,643**	135,325	8,565,816
4/87 - 3/88	8,092,904	**8,776,323**	-548,094	8,956,364
4/88 - 3/89	8,019,940	**8,296,657**	-824,811	8,640,980
4/89 - 3/90	8,957,741	**7,678,441**	454,489	8,466,992
4/90 - 3/91	9,452,711	**8,482,485**	1,424,715	8,452,823
4/91 - 3/92	8,415,824	**8,917,840**	922,699	9,209,992
4/92 - 3/93	7,036,176	**8,845,494**	-886,619	8,476,645
4/93 - 3/94	6,901,929	**9,273,869**	-3,258,559	8,213,351
4/94 - 3/95	11,579,284	**9,631,077**	-1,310,352	9,835,677
4/95 - 3/96	12,039,388	**13,270,353**	-2,541,317	13,003,494
4/96 - 3/97	11,816,525	**11,001,903**	-1,726,694	11,571,565
4/97 - 12/97 (9 mths.)	9,095,704	**11,151,104**	-3,782,094	8,037,339
1/98-12/98	8,308,962	**8,912,022**	-4,385,154	8,447,126
1/99-12/99	8,753,333	**8,066,693**	-3,698,515	8,475,963
Total	**174,749,587**	**178,448,102**	**-3,985,515**	**167,951,859**
Future Commitments to December 31, 2001		6,584,220		
Total Commitments		**185,032,322**		

Figures are based on audited financial statements.

'Grant Commitments' includes Research Grants, Postdoctoral and Research Fellowships and Workshops.

Grant Commitments are following the deduction of unexpended allocations.

Table 10:
Impact of US Dollar Devaluation on the BARD Research Budgets, 1979-1999 (Thousands of US $)

Award Year	Total		Average per Project		
	Nominal US$ value	1978 US$ value	Requested Budget	Nominal US$ value	1978 US$ value
80	7,369	7,369	203	149	149
80	3,991	3,522	188	148	130
81	6,202	4,870	226	175	137
81	8,149	6,399	246	164	129
82	6,964	5,020	263	174	125
83	6,470	4,490	253	178	124
84	7,238	4,839	252	203	135
85	9,170	5,897	278	200	129
86	7,860	4,871	273	178	110
87	7,970	4,884	273	196	120
88	7,709	4,525	264	200	117
89	7,463	4,196	298	212	119
90	9,505	5,107	288	230	124
91	9,000	4,555	293	246	124
92	7,545	3,707	311	223	109
93	10,666	5,090	308	267	128
94	9,903	4,600	321	297	138
95	11,034	4,993	330	302	137
96	10,896	4,807	348	316	139
97	11,000	4,699	341	310	132
98	7,985	3,353	356	282	118
99	6,220	2,570	359	264	109
Total	**180,309**	**101,791**			

Table 10

List 1:
Review Panel Chairpersons, 1988-1999

Agricultural Economics		
Brorsen, W.	OK State U	98-
Buccola, S.	OR State U	97-8
Christensen, C.	EES, USDA	95
Feinerman, E.	Hebrew U	91
Fishelson, G.	Hebrew U	92
Gardner, B.	TX A&M U	92-3
Hueth, D.	U MD	90-1
Kimhi, A.	Hebrew U	99
Kislev, Y.	Hebrew U	89, 93
Plessner, Y.	Hebrew U	96-8
Regev, U.	Ben Gurion U	88
Shilony, Y.	Bar Illan U	94-5
Wohlgenant, M.	NC State U	96
Zusman, P.	Hebrew U	90

Animal Production		
Arieli, A.	Hebrew U	95-7
Bartov, I.	ARO, Bet Dagan	89-90
Cartwright, L.	TX A&M U	96-7
Cecil, H.	ARS, Beltsville	89-91
Chase, C.	ARS, FL	93-5
Cundiff, L.	ARS, NE	96-7
Dodgson, J.	MI State U	98-9
Elsasser, T.	ARS, Beltsville	90-2
Friedman, A.	Hebrew U	98*
Gertler, A.	Hebrew U	93-4
Hawk, H.	ARS, Beltsville	88
McMurtry, J.P.	ARS, Beltsville	92
Pines, M.	ARO, Bet Dagan	91-2
Proudman, J.	ARS, Beltsville	93-5
Rumsey, T.	ARS, Beltsville	88-9
Sklan, D.	Hebrew U	88
Wiggans, G.	ARS, Beltsville	98-

Agricultural Engineering		
Beasley, D.B.	U GA	90
Bode, L.	U IL	91-3
Brusewitz, G.	OK State U	93-4
Delwiche, M.	U CA, Davis	96-9
Edan, Y.	Ben Gurion U	94-5
Galili, N.	Technion	92-3
Harris, L.	ARS, Beltsville	89
Haugh, G.	VA Poly & State	91-2
Miles, G.	Purdue	99-
Nave, W.R.	ARS, Beltsville	89
Paterson, D.L.	ARS, WV	97
Peart, R.	U FL	94-5
Peiper, U.	ARO, Bet Dagan	88-9
Ross, J.	U KY	95-6
Sarig, Y.	ARO, MARD	90-1
Schmilovitch, Z.	ARO, Bet Dagan	99*
Stewart, L.	U MD	88
Threadgill, D.	U GA	90
Williamson, R.	Clemson U	98-
Zion, B.	ARO, Bet Dagan	96-8

Animal Protection		
Bolin, C.	ARS, Ames	89-92
Breeze, R.	ARS, Plum Island	88
Danforth, H.	ARS, Beltsville	97-
Elad, D.	Israel Vet. Services	94-6
Ellis, R.	CO State U	93-6
Evermann, J.F.	WA State U	90-1
First, N.	U WI	89
Gamble, R.	ARS, Beltsville	93-6
Ivie, W.	TX A&M	89-90
Lublin, A.	Israel Vet. Services	97-8
Markovics, A.	Israel Vet. Services	91-3
Orgad, U.	Israel Vet. Services	99*
Shlosberg, A.	Israel Vet. Services	88-90
Songer, J.G.	U AZ	92
Splitter, G.	U WI	97-

List 1 continues

List 1:
Review Panel Chairpersons, 1988-1999

Aquaculture		
Davis, J.	TX A&M	89
Diamant, A.	IOLR	97-8
Dunham, R.	Auburn U	98-9
Geider, R.J.	U DE	92
Harrell, R.M.	U MD	93
Hulata, G.	ARO, Bet Dagan	90, 94-6
Lorio, W.	ARS, Lane	88
Lubzens, E.	IOLR.	91-3
Mann, R.	VA IMB	99-
Parker, N.	TX A&M	89-90
Price, K.	U DE	93-5
Ramus, J.	NC State U	90-1
Reigh, R.	LA State U	96-8
Schwedler, T.E.	Clemson U	97
Torrans, E.	Fish & Wildlife	91-2
VanRijn, J.	Hebrew U	99
Wheaton, F.W.	U MD	94
Wolters, W.	ARS, Stoneville	95-6
Yaron, Z.	Tel Aviv U	88-9

Cellular & Molecular Biology in Ag		
Anderson, J.D.	ARS, Albany	88-9
Ben-Hayyim, G.	ARO, Bet Dagan	90
		96-8
Bray, E.	U CA, Riverside	92-4
Carmeli, C.	Tel Aviv U	88
Carpita, N.	Purdue	92-3,
		96-7
Crain, R.C.	U CT	95
Deitzer, G.	U MD	90-1
Edelman, M.	Hebrew U	89
Gafni, Y.	ARO, Bet Dagan	93-5
Galili, G.	Weizmann Inst.	92
Giovannoni, J.	TX A&M	99-
Glazebrook, J.	U MD	98
Granot, D.	ARO, Bet Dagan	99-
Hammond, R.W.	ARS, Beltsville	95
Herman, E.	ARS, Beltsville	90-2
Hutcheson, S.W.	U MD	91
Jones, A.	NC State U	94-5
Keegstra, K.	U WI	90
Martin, G.	Purdue	96-7
McCormick, S.	ARS, Albany	92-3
Newton, W.	ARS, Albany	88
Owens, R.A.	ARS, Beltsville	89
Pring, D.R.	ARS, Gainesville	88
Steffens, J.	Cornell U	95-6
Stern, D.	Boyce Thompson	97-8
Stone, R.T.	ARS, Clay Cent.	89
Tucker, M.	ARS, Beltsville	94, 98-
Vanderwoude WJ	ARS, Beltsville	88-9
Wolniak, S.M.	U MD	90
Zamir, D.	Hebrew U	91
Anderson, J.D.	ARS, Albany	88-9

List 1 continues

List 1:
Review Panel Chairpersons, 1988-1999

Field and Garden Crops		
Aloni, B.	ARO, Bet Dagan	88, 99-
Ashri, A.	Hebrew U	1993
Ben-Tal, Y.	ARO, Bet Dagan	97-8
Bauchan, G.R.	ARS, Beltsville	96
Coffman, B.	ARS, Beltsville	96-7
Goyal, A.	U MN	99-
Handa, A.	Purdue	98-
Hokanson, S.	ARS, Beltsville	98
Jones, R.	Purdue	99-
Kapulnik, Y.	ARO, Bet Dagan	89
Kigel, J.	Hebrew U	94-6
Labavitch, J.	U CA, Davis	92-3
Mattoo, A.	ARS, Beltsville	98
McMichael, B.	ARS, Lubbock	90-91
Miller, P.	ARS, Lincoln	88-9
Quisenberry, J.	ARS, Lubbock	89-1
Raviv, M.	Hebrew U	91-2
Shelton, D.	ARS, Beltsville	97
Shennan, C..	U CA, Davis	94-5
Steinitz, B.	ARO, Bet Dagan	90
Stommel, J.	ARS, Beltsville	94-6
Stoner, A.	ARS, Beltsville	94-5
Teasdale, J.	ARS, Beltsville	93
Tworkoski, T.	ARS, WB	97
Webster, B.D.	U CA, Davis	92

Fruit Tree Crops		
Ben-Arie, R.	ARO, Bet Dagan	97-8
Ben-Tal, Y.	ARO, Bet Dagan	88-9
Cameron, S.	WA State U	95-8
Erner, Y.	ARO, Bet Dagan	90-4
Fuchigami, L.	OR State U	99-
Gmitter, F.	ARS, Lk. Alfred	92-6
Kender, W.	U FL	92-5
Labavitch, J.	U CA, Davis	91
Mitchell, C.	Purdue	88-9
Moore, G.	U FL	97-9
Ng, T.	U MD	90-2
Riov, Y.	Hebrew U	99
Sagee, O.	ARO, Bet Dagan	95-6
Webster, B.D.	U CA, Davis	90-1
Weinbaum, S.	U CA, Davis	92-3
Wisniewski, M.	ARS, WV	99-

Plant Protection		
Brodie, B.	ARS, Ithaca	88-9
Carruthers, R.	ARS, Beltsville	95
Civerolo, E.	ARS, Beltsville	88-9
Cooksey, D.	U CA, Riverside	97-9
Coppedge, J.	ARS, Beltsville	91-3
Culver, J.	U MD	95
Dunkelblum, E.	ARO, Bet Dagan	89
Elad, Y.	ARO, Bet Dagan	92-3
Falk, B.	U CA, Davis	99
Fravel, D.	ARS, Beltsville	94
Garnsey, S.	ARS, Orlando	97-8
Hefetz, A.	Tel Aviv U	96
Hopkins, D.	ARS, Leesburg	96
Irwin, M.	U IL	94
Leath, S.	NC State U	94-5
Manulis, S.	ARO, Bet Dagan	97-8
Mitchell, E.	ARS, Gainesville	90
Niblack, T.	U MO	97-9
Quimby, P.	ARS, Stoneville	91-3
Raccah, B.	ARO, Bet Dagan	88
Roberts, D.	Boyce Thompson	88
Salomon, R.	ARO, Bet Dagan	94-5
Soper, R.	ARS, Beltsville	89-90
Spiegel, Y.	ARO, Bet Dagan	90-1
Steward, N.	U NC	94
Taylorson, R.	ARS, Beltsville	88
Timmer, L.W.	U FL	90
Ueng, P.	ARS, Beltsville	95-6
Vanderzwet, T.	ARS, Kearneysville	91-3
Webb, S.	U FL	98-9
Wilson, C.	ARS, Kearneysville	88
Wyatt, S.	WA State U	96
Yarden, O.	Hebrew U	99
Yokomi, R.	ARS, Parlier, CA	96-8

List 1 continues

List 1:
Review Panel Chairpersons, 1988-1999

Postharvest & Food Science		
Bourne, M.	Cornell U	93-6
Buchanan, R.	ARS, Beltsville	91-2
Chalutz, E.	ARO, Bet Dagan	91-2
Fuchs, Y.	ARO, Bet Dagan	95
Handa, A.	Purdue U	89-90
Juven, B.	ARO, Bet Dagan	89-90
Kader, A.	U CA, Davis	98-9
Kline, B.	U IL	89
Lers, A.	ARO, Bet Dagan	99-
Miller, A.	ARS, Wyndmoor	93-6
Navarro, S.	ARO, Bet Dagan	88-9
PhilosophHadas S	ARO, Bet Dagan	93-4
Prusky, D.	ARO, Bet Dagan	96-8
Robens, J.	ARS, Beltsville	91-2
Rouseff, R.	U FL	99-
Sapers, G.	ARS, Wyndmoor	96-8
Shewfelt, R.	U GA	88-90
Thomas, R.	Clemson U	90
Toledo, R.	U GA	97-8

Soil, Water, Air & Environment		
Bar-Yosef, B.	ARO, Bet Dagan	92-4
Benjamin, J.	ARS, Akron, CO	96-99
Box, J.	ARS, Watkinsville	92-3
Dasberg, S.	ARO, Bet Dagan	88-9
Dowdy, R.	ARS, St. Paul	92-3
Follett, R.	ARS, Ft. Collins	89
Fuchs, M.	ARO, Bet Dagan	97-8
Heermann, D.	ARS, Ft. Collins	94-5
Keren, R.	ARO, Bet Dagan	90-1
Kunze, R.	MI State U	91
McNeal, B.	U FL	90
Mingelgrin, U.	ARO, Bet Dagan	93
Nielsen, D.	U CA, Davis	94-5
Ravina, I.	Technion	95-6
Robinson, D.	LA State U	91
Shani, U.	Hebrew U	99-
Stewart, B.	ARS, Bushland	89-90
Vigil, M.	ARS, Akron, CO	96-8
Wienhold, B.	ARS, Lincoln	98-
Williams, J.	ARS, Temple	88
Bar-Yosef, B.	ARO, Bet Dagan	92-4

List 2:
Technical Advisory Committee Members, 1988-1999

Member	Affiliation	Term
Aharoni, Nehemia	ARO, Bet Dagan	1996-1998
Aharonson, Nadav	ARO, Bet Dagan	1990-1992
Alper, Yekutiel	ARO, Bet Dagan	1996-1997
Ashri, Amram	Hebrew University, Rehovot	1990-1992
Barash, Isaac	Tel Aviv University	1993-1995
Ben-Arie, Ruth	ARO, Bet Dagan	1991-1993
Bennett, Alan	U California, Davis	1993-1996
Boyer, John	U Deleware	1996-1998
Cahaner, Avigdor	Hebrew University, Rehovot	1998-2000
Campion, Denny	U Illinois	1995-1997
Chalutz, Edo	ARO, Bet Dagan	1988-1990
Chen, Yona	Hebrew University, Rehovot	1991-1993
Clarke, Neville	Texas A&M	1989-1990
Cohn, Eli	ARO, Bet Dagan	1988-1989
Cook, R. James	ARS, USDA – Pullman	1994-1997
Craig, James	ARS, USDA – Wyndmoor	1991-1993
Finney, Essex	ARS, USDA – Wyndmoor	1988-1990
Folman, Yeshayahu	ARO, Bet Dagan	1988-1990
Gengenbach, Burle	U Minnesota	1990-1992
Goodrich, Richard	U Wisconsin	1991-1994
Hefetz, Abraham	U Tel Aviv	1999-2001
Hodges, Thomas	Purdue	1995-1997
Holsinger, Virginia	ARS,USDA – Wyndmoor	1996-1998
Katan, Yaacov	Hebrew U, Rehovot	1996-1998
Keen, Noel	U California, Riverside	1998-2000
Kemper, Doral	ARS, USDA – Beltsville	1987-1989
Keren, Rami	ARO, Bet Dagan	1999-2001
Kinsella, John	Cornell U	1989-1991
Kislev, Yoav	Hebrew U, Rehovot	1987-1989
Marom, Dan	Extension Service, MARD	1989-1991
Martinez, Wilda	ARS, USDA – Beltsville	1993-1995
Miksche, Jerome	ARS, USDA - Beltsville	1988-1990
Miller, Phillip	ARS,USDA, Lincoln	1990-1992
Mingelgrin, Uri	ARO, Bet Dagan	1998-2000
Moser, Bruno	Purdue U	1991-1993
Orgad, Uriel	Veterinary Services, MARD	1993-1995
Ort, Donald	ARS, USDA - Urbana	1998-2001
Palmer, Guy	Washington State U	1999-2001
Riov, Yossi	Hebrew U, Rehovot	1995-1997
Sagiv, Ya'akov	MARD	1988-1990
Sarig, Yoav	ARO, Bet Dagan	1998-2000
Seginer, Ido	Technion	1992-1994
Seligman, Noam	ARO, Bet Dagan	1994-1996
Shalhavet, Yossi	ARO, Bet Dagan	1994-1997
Tizzard, Ian	Texas A&M	1988
Wall, Robert	ARS, USDA - Beltsville	1998-2001
Welsh, James	U Montana	1988-1990

List 3:
Funded Institutions in the United States, 1979-1999 (in US $)

State	Institution	# of Funded Projects	Total Funding	% of Total Allocation
Alabama	University of Alabama	2	153,000	0.19
	Auburn University	12	1,020,830	1.25
	Tennessee Valley Authority	1	100,000	0.12
	Tuskegee University	2	82,000	0.10
Arizona	University of Arizona	14	1,311,220	1.60
	Arizona State University	1	100,000	0.12
Arkansas	University of Arkansas	1	152,900	0.19
California	California Institute of Tech.	2	130,500	0.16
	University of California:			
	Berkeley	21	1,302,510	1.59
	Davis	83	8,136,419	9.95
	Irvine	1	100,000	0.12
	Los Angeles	3	88,000	0.11
	Riverside	50	3,808,706	4.66
	Santa Barbara	1	59,240	0.07
	Santa Cruz	1	109,250	0.13
	San Diego	1	77,500	0.09
	Los Angeles Co. Fire Dept.	1	17,700	0.02
	Stanford University	3	357,180	0.44
	The Scripps Research Inst.	1	147,300	0.18
Colorado	Colorado State University	7	666,575	0.81
Connecticut	University of Connecticut	6	546,180	0.67
	Yale University	7	430,652	0.53
Dist. Columb.	Carnegie Inst. Washington	2	67,690	0.08
	Int'l Bank Reconstruction	2	1,750	0.00
Delaware	University of Delaware	2	290,230	0.35
Florida	University of Florida	49	4,944,005	6.04
	University of South Florida	2	188,800	0.23
	Florida State University	1	90,000	0.11
	University of Miami	1	3,750	0.00
	University of Tampa	1	42,000	0.05
Georgia	University of Georgia	17	1,380,220	1.69
Hawaii	University of Hawaii	6	781,200	0.95
Idaho	University of Idaho	5	451,770	0.55

List 3 continues

List 3:
Funded Institutions in the United States, 1979-1999 (in US $)

State	Institution	# Funded Projects	Total Funding	% of Total Allocation
Illinois	University of Chicago	2	160,110	0.20
	University of Illinois	20	1,950,422	2.38
Indiana	Purdue University	25	2,604,745	3.18
	Indiana University	1	4,400	0.01
Iowa	Iowa State University	15	1,460,495	1.79
Kansas	University of Kansas	2	69,300	0.08
	Kansas State University	3	287,120	0.35
Kentucky	University of Kentucky	6	550,970	0.67
Louisiana	Louisiana State University	2	100,000	0.12
	Tulane University	1	70,300	0.09
Maryland	University of Maryland	12	783,740	0.96
	National Institutes of Health	1	1,875	0.00
Massachusetts	University of Massachusetts	10	754,460	0.92
	Harvard University	1	3,000	0.00
	Massachusetts Inst. Tech.	3	144,733	0.18
	Woods Hole Inst.	1	43,650	0.05
Michigan	University of Michigan	6	566,700	0.69
	Michigan State University	24	1,640,215	2.01
Minnesota	University of Minnesota	17	1,342,780	1.64
Missouri	University of Missouri	3	197,020	0.24
	George Washington University	1	63,400	0.08
Montana	University of Montana	2	62,650	0.08
	Montana State University	7	432,529	0.53
Nebraska	University of Nebraska	7	842,810	1.03
Nevada	University of Nevada	1	150,000	0.18
New Jersey	Rutgers University	9	998,820	1.22
New Mexico	NM Inst. Mining & Tech.	1	94,110	0.12
	New Mexico State University	3	333,976	0.41
New York	Brookhaven National Lab.	2	86,600	0.11
	Boyce Thompson Institute	3	383,860	0.47
	City University of New York	3	181,630	0.22
	Cornell University	71	6,240,187	7.63
	New York University	1	90,000	0.11
	State University of New York	4	460,010	0.56
	University of Rochester	1	149,900	0.18

List 3 continues

List 3:
Funded Institutions in the United States, 1979-1999 (in US $)

State	Institution	# Funded Projects	Total Funding	% of Total Allocation
North Carolina	Duke University	1	120,000	0.15
	East Carolina University	1	60,700	0.07
	University of North Carolina	3	159,800	0.20
	North Carolina State University	20	1,653,670	2.02
	Wake Forest University	1	34,500	0.04
Ohio	Ohio State University	11	1,119,428	1.37
	Case Western Reserve	2	266,000	0.33
Oklahoma	University of Oklahoma	1	90,000	0.11
	Oklahoma State University	1	116,900	0.14
Oregon	Oregon State University	5	515,480	0.63
	University of Oregon	2	276,000	0.34
Pennsylvania	Fox Chase Cancer Center	2	100,750	0.12
	Monell Chemical Senses	1	53,130	0.06
	University of Pennsylvania	3	288,790	0.35
	Pennsylvania State University	9	1,154,940	1.41
Puerto Rico	University of Puerto Rico	2	199,200	0.24
South Carolina	SC Wildlife & Marine Research	2	51,600	0.06
	SC Dept. of Nat'l Resources	1	161,600	0.20
	Clemson University	10	845,690	1.03
Tennessee	Tennessee Tech. University	2	37,150	0.05
	University of Tennessee	1	97,500	0.12
	World Health Organization	1	2,500	0.00
Texas	Texas A&M University	38	3,839,215	4.69
	Texas Tech. University	7	707,400	0.86
	University of Texas	1	52,500	0.06
Utah	Brigham Young University	2	148,100	0.18
	Utah State University	12	1,027,350	1.26
Vermont	University of Vermont	1	147,500	0.18
Virginia	VA Inst. of Marine Sciences	2	8,000	0.01
	Virginia Polytechnic Institute	21	1,654,163	2.02
	University of Virginia	1	105,000	0.13
	Virginia State University	1	57,430	0.07

List 3 continues

List 3:
Funded Institutions in the United States, 1979-1999 (in US $)

State	Institution	# Funded Projects	Total Funding	% of Total Allocation
Washington	University of Washington	3	247,950	0.30
	Washington State University	17	1,653,596	2.02
Wisconsin	University of Wisconsin	19	1,676,910	2.05
Wyoming	University of Wyoming	2	230,000	0.28
Nationwide	USDA-ARS[4]	182	12,399,340	15
		971	**81,805,375**	**100**

971 institutions in the United States have received a total of $81,805,376 in BARD funding.

BARD has funded 850 projects; some have more than one participating institution in the United States.

Affiliates of the *National Association of State Land Grant Universities and Colleges* (NASLGUC) have received $63,438,658 (77% of total in the US).

USDA's Agriculture Research Service (ARS) has received $12,399,340 (15% of total in the US) and has participated in 182 BARD funded projects.

List 4:
BARD Awards to USDA-ARS Locations, 1979-1999

State	ARS Location	# of Projects
Alabama	Auburn	1
Arizona	Phoenix	3
	Tucson	3
California	Albany	8
	Berkeley	1
	Davis	1
	Fresno	6
	Riverside	9
	Salinas	3
	Shafter	1
Colorado	Fort Collins	1
Delaware	Newark	1
Florida	Gainesville	10
	Miami	1
	Lehigh Acres	1
	Orlando	5
	Winter Haven	1
Georgia	Athens	4
	Savannah	4
	Tifton	2
Idaho	Aberdeen	1
Illinois	Urbana	1
Indiana	West Lafayette	2
Iowa	Ames	3

State	ARS Location	# of Projects
Maryland	Beltsville	56
	Frederick	1
Michigan	East Lansing	12
Minnesota	St. Paul	2
	Morris	1
Mississippi	Stoneville	1
Missouri	Columbia	1
Montana	Bozeman	2
Nebraska	Lincoln	2
New Jersey	Cape May	1
New York	Greenport LI	3
North Carolina	Raleigh	1
Oklahoma	Durant	1
	Stillwater	1
Oregon	Corvallis	2
Pennsylvania	Wyndmoor	3
South Carolina	Charleston	3
Texas	Bushland	1
	Lubbock	1
	Weslaco	2
Washington	Pullman	4
	Wenatchee	1
West Virginia	Kearneysville	6
Wisconsin	Madison	1

BARD has awarded funding to 182 ARS locations

List 5:
Funded Institutions in Israel, 1979-1999

Note: Total number of approved projects is 850; project may have more than one participating institution per country.

Institution	# of Projects	Allocated Funds (US dollars)	% of Total Allocation in Israel
ARO - Agricultural Research Organization	482	48,546,981	49.28
Bar Illan University	13	1,033,890	1.05
Ben Gurion University	15	1,243,399	1.26
Center for Agricultural Economic Research	18	1,152,460	1.17
Eilot Regional Council	3	355,800	0.36
Hahaklait	2	32,600	0.03
Haifa University	3	254,000	0.26
Hebrew University of Jerusalem	252	22,455,286	22.80
Institute for Farm Income Research	1	33,499	0.03
Israel Atomic Energy Commission	1	75,000	0.08
Israel Citrus Marketing Board	7	202,580	0.21
Israel Meteorological Institute	1	14,900	0.02
Israel Oceanographic Institute	23	2,452,380	2.49
Kimron Veterinary Institute	71	6,120,162	6.21
Migal Galilee Technological Center	3	167,300	0.17
Ministry of Agriculture, Extension Service	18	336,900	0.34
Ministry of Health	2	106,167	0.11
Sivan Granot	1	169,000	0.17
Tahal Water Planning	1	10,000	0.01
Technion R&D Foundation	47	4,169,675	4.23
Tel Aviv University	60	5,234,975	5.32
Weizmann Institute of Science	45	4,336,571	4.40
Total	**1,069**	**98,503,525**	**100**

List 6:
Postdoctoral Fellows, Host Laboratory and Present Affiliation

Fellows from the USA who worked in Israeli Labs

Fellow	Host & Institution	Present Affiliation
T. Berke	A. Bar-Zur - ARO	Taiwan
E. Boehm	R. Fluhr, T. Katan – ARO	-
E. Clark	Y. Gafni - ARO	U CA Berkeley
C. DiFonzo	B. Raccah – ARO	-
K. Elias	T. Katan - ARO	-
I. Goldman	D. Zamir - Hebrew U	Horticulture, UWI
K. Hambright	M. Gophen - IOLR	IOLR
S. Jones	S. Friedman - ARO	Utah St. U
J. Klein	R. Ben-Arie – ARO	Field Crops, ARO
R. Martin	R. Ben-Arie – ARO	Vegetable Crops, U CA Davis
L. Morrison	M. Feldman – Weizmann Inst	-
Y. Palti	G. Hulata – ARO	Food Engineering, Technion
R. Weisburd	T. Berman – IOLR	U Tsukuba, Japan
M. Schaffer	R. Fluhr – Weizmann Inst	-
E. Steinberger	M. Bar-Joseph - ARO	U CA, Davis

Fellows from Israel who worked in US Labs

Fellow	Host & Institution	Present Affiliation
A. Andrawis	R. W. Buescher – U CA Riverside	-
O. Ardon	J. Kaplan -U Utah	Current Postdoc
M. Band	H.A. Lewin - U Illinois	U Illinois
U. Bar-Peled	L. Hennighausen – NIH	Israel Min. of Health
H. Ben-David	W. Gruissem - U CA Berkeley	Israel Min. of Health
G. Bloch	G. Robinson - U Illinois	U Illinois
E. Brill	R.E. Just – U Maryland	Ag Econ Center, HUJI
O. Carmi	E. W. Nester - U Washington	-
B. Chefetz	P.G. Hatcher – Ohio St. U	Chemistry, OSU
J. Cnaani	J.O. Schmidt – USDA, ARS	Current Postdoc
Y. Cohen	P. Zambryski - U CA Berkeley	-
O. Dahan	S.W. Tyler -Desert Res. Inst, NV	Current Postdoc
N. Deeb	S.J. Lamont - Iowa St U	Current Postdoc
Y. Eshed	J.L. Bowman – U CA Davis	U CA Davis
Y. Eyal	S.M. McCormick -USDA ARS	Horticulture, ARO
O. Faktor	C.J. Lamb - Salk Inst	Entomology, FA, HUJI
E. Fallik	R.L. Robson -U Georgia	Postharvest, ARO
S. Freeman	R.J. Rodriguez - U CA Riverside	Plant Protection, ARO
M. Flaishman	P.E. Kolattukudy - Ohio St. U	Horticulture, ARO
R. Gafny	R.N. Beachy - G Wash U	Plant Protection, ARO
Y. Gazit	J.H. Tumlinson - USDA ARS	Citrus Marketing

List 6 continues

List 6:
Postdoctoral Fellows, Host Laboratory and Present Affiliation

Fellow	Host & Institution	Present Affiliation
S. Gilboa	R.T. Roush - Cornell U	-
Y. Goldwasser	J.I. Yoder - U CA Davis	Current Postdoc
E. Golenberg	M. T. Clegg - U CA Riverside	-
H. Guterman	G. Stephanopoulos – MIT	Ben Gurion U
G. Gvaryahu	D. L. Cunningham - Cornell U	Animal Science, FA, HUJI
A. Haberfeld	E.A. Dunnington – VA Poly	-
S. Haran	I. Raskin - Rutgers U	-
A. Harari	P.J. Landolt - USDA ARS	Plant Protection, ARO
S. Harpaz	M. R. Kare - Monell Chemical	Animal Sciences, ARO
Y. Heifetz	M. Wolfnet – Cornell U	Cornell U
A. Heilig	T. Steenhuis – Cornell U	Cornell U
D. Holland	P.C. Wolk - Michigan St. U	Horticulture, ARO
N. Ilan	S.A.N. Goldstein – Yale	Current Postdoc
Y. Inbar	H.A.J. Hoitink- Ohio St. U	Soil &Water, FA, HUJI
Y. Kapulnik	D. A. Phillips -U CA Davis	Field Crops, ARO
Z. Kerem	K.E. Hammel – USDA, ARS	Food Sci. & Nutrit. FA, HUJI
S. Kolkovski	K. Dabrowski – Ohio St. U	-
H. Koltai	D.M. McKenzie-Bird - NC St U	Current Postdoc
T. Kunick	C. Dingwall - NYSU, Stony Brook	Current Postdoc
M. Lapidot	R.N. Beachy – G. Wash U (MO)	Plant Protection, ARO
A. Levine	C.J. Lamb - Salk Inst	Plant Sciences, HUJI
E. Levy	F.J. Gough – USDA, ARS	Ministry of Agriculture
A. Lichter	W.O. Mills – Oregon St. U	Postharvest, ARO
A. Lotan	S. Maeda – U CA Davis	Cell & Animal Biology, HUJI
R. Mandelbaum	L.P. Wackett – U Minnesota	Soil & Water, ARO
Y. Marcus	J. A. Berry - Carnegie Inst	-
M. Mawassi	W.O. Dawson – U Florida	Plant Protection, ARO
R. Mayer	N.H. Chua - Rockefeller U	Ag. Botany, FA, HUJI
J. Miron	M. T. Yokoyama - Michigan St U	Animal Science, ARO
T. Mor	C.J. Arntzen - Boyce-Thom Inst.	-
H. Moshkowitz	B. D. Hammock -U CA Davis	-
A. Nasser	M. Cheney – Rutgers U	-
A. Olesinski	I. Raskin - Rutgers U	Hazera, Mivhor
E. Or	B. Larkins – U Arizona	Horticulture, ARO
N. Ori	S. Hake – USDA, ARS	-
H. Peleg	A.C. Noble – U CA Davis	-
Y. Pinchasov	L. S. Jensen - U Georgia	Animal Science, FA, HUJI
J. Pitcovski	S. J. Lamont - Iowa St. U	MIGAL
R. Porat	S.D. O'Neill – U CA Davis	Postharvest, ARO
M. Ron	G.A. Gutman - U CA Irvine	Animal Sciences, FA, HUJI
R. Rosenberg	HM Kronenberg - MA Gen Hosp.	-
D. Rosenfeld	R.P. Rohrbach - N. Carol. St. U	-
A. Sabehat	A.B. Bennett - U CA Davis	-

List 6 continues

List 6:
Postdoctoral Fellows, Host Laboratory and Present Affiliation

Fellow	Host & Institution	Present Affiliation
O. Sagee	C.J. Lovatt - U CA Riverside	Horticulture, ARO
A. Sagi	H. Laufer - U Connecticut	Ben Gurion U
G. Sessa	G.B. Martin - Purdue U	Tel Aviv University
H. Schickler	J. Messing - Rutgers U	Horticulture, FA, HUJI
N. Shapir	L.P. Wackett- U Minnesota	Current Postdoc
A. Sharon	O.C. Yoder - Cornell U	Botany, TAU
O. Shoseyov	R.H. Doi - U CA Davis	Horticulture, FA, HUJI
D. Shtienberg	W. E. Fry - Cornell U	Plant Pathology, ARO
L. Singher	G.E. Miles - Purdue U	Agr Engineering, Technion
Y. Sitrit	A.B. Bennett - U CA Davis	Plant Botany, Weizmann Inst.
A. Sivan	G.E. Harman - Cornell U	Ben Gurion U
R. Solomon	D.E. Bauman – Cornell U	Cornell U
M. Tom	M. Fingerman - Tulane U	IOLR, Haifa
T. Trebitsh	S.D. O'Neill -U CA Davis	Plnt Genetics, Weizmann Inst.
T. Tzfira	V. Citovsky - NYSU, Stony Brook	Current Postdoc
Z. Uni	K.A. Schat - Cornell U	Animal Science, FA, HUJI
A. Vainstein	E. M. Tobin - U CA Los Angeles	Horticulture, FA, HUJI
H. Volpin	D.A. Phillips – U CA Davis	Not in Agriculture
C. Wattad	N.T. Keen - U CA Riverside	Not in Agriculture
Z. Wiesman	A.K. Mattoo – USDA, ARS	Horticulture, ATO
D. Yakir	M.J. DeNiro - U CA Los Angeles	Environ. Sci., Weizmann Inst.
O. Yakir	S.V. Beer - Cornell U	-
S. Yalovsky	W. Gruissem - U CA Berkeley	-
O. Yarden	C. Yanofsky – Stanford U	Plant Path., Microb. FA, HUJI
N. Yonash	H.H. Cheng – USDA, ARS	Animal Science, U CT
E. Zchori-Fein	J.K. Brown – U Arizona	Current Postdoc
M. Zeidan	D.P. Maxwell - U Wisconsin	Plant Protection Serv., MARD

List 7:
Supported Workshops, 1989-1999

Workshop Title	Organizers, Location and Year
Postharvest Heat Treatments: Effects on Commodity, Pathogens and Insect Pests.	*S. Lurie, ARO, Bet Dagan, Robert Paull, Roy McDonald, (Israel, 2000)*
Microbial Food Contamination.	*C. Wilson, USDA-ARS; S. Droby, ARO, Bet Dagan; (Shepherdstown, WV, 1998)*
Host Specificity, Pathology and Host Pathogen Interaction of Colletotrichum.	*D. Prusky, ARO, Bet Dagan, M.B. Dickman, U Nebraska, Lincoln, (Israel 1998)*
Management of Soilborne Plant Pathogens	*I. Chet, The Hebrew University of Jerusalem; R.J. Cook, Washington State University; Y. Katan, The Hebrew University of Jerusalem. (Israel, 1998)*
International Workshop on QTL Detection and Marker Assisted Selection.	*J. Weller, ARO, M. Soller, The Hebrew University of Jerusalem; A. Korol, Haifa University; L.B. Hansen, University of Minnesota. (Israel, 1997)*
Modified Atmosphere Packaging (MAP) of Agricultural Produce	*S. Ben Yehoshua, ARO; A. Kader, U California, Davis. (Israel, 1997)*
The Third International Workshop on Basic and Applied Research in Plasmodesmal Biology.	*B. Epel, Tel Aviv University; S. Wolf, Faculty of Agriculture, The Hebrew University of Jerusalem; R. Beachy, The Scripps Research Institute; W. Lucas, University of California, Davis. (Israel, 1996)*
Modern Agriculture and the Environment	*E. Tel-Or, Y. Chen: Faculty of Agriculture, Rehovot; J.E. Casida, U Cal, Berkeley (Israel, 1994))*
An Assessment of the Biology and Management Strategies for *Bemisia tabaci* from an International Perspective.	*D. Gerling: Tel Aviv U; R.T. Mayer: USDA-ARS, Orlando, FL; M. Berlinger: ARO; J. Coppedge: USDA-ARS, Beltsville, MD; S. Cohen: ARO; R. Faust: USDA-ARS, Beltsville, MD (Israel, 1993)*
The Political Economy of Agricultural Policy Comparative: Theoretical and Empirical Perspectives.	*E. Hochman: Hebrew U; G.C. Rausser: UC Berkeley; D. Zilberman: UC Berkeley. (Israel, 1993)*
Non-conventional Control of Plant-Parasitic	*Y. Spiegel: ARO; D.T. Kaplan: USDA-ARS, Orlando, FL (Israel, 1994)*
Applying Plant-Microbe Symbioses to Agriculture	*D.A. Phillips: U California, Davis; Y. Kapulnik: ARO (Israel, 1991)*
An Integrated Non-Destructive On-Line System for Quality Evaluation of Fruits and Vegetables	*Y. Sarig: ARO; G.K. Brown: USDA-ARS, East Lansing, MI (US, 1993)*
New Targets for Insect Management in Crop Protection	*N. Aharonson: ARO; J. Menn: USDA, Beltsville, MD (Israel, 1991)*
Biological Control of Postharvest Diseases of Fruits and Vegetables	*E. Chalutz: ARO; C.L. Wilson: USDA, Kearneysville, WV (US, 1990)*
International Workshop on Agricultural Cooperation	*Y. Kislev: Hebrew U, Rehovot; S.T. Buccola: U Oregon (Israel, 1991)*

List 8:
Members of the Board of Directors

Member	Affiliation	Service Years
Acker, D.	Administrator, OICD, USDA	1990-(1994)
Amiad, A.	Director, ARO, MARD	1990
Arkean, I.	Budget Director, MIF	1980
Beattie, J.M.	Dean & Director ES, Penn State U	1979-1981
Bertrand, A.	Administrator, ARS, USDA	1980
Boaz, D.	Budget Director, MIF	1988-1991
Brodet, D.	Budget Director, MIF	1992-1996
Dovrat,	Budget Director, MIF	1987
Edminister, T.W.	Administrator, ARS, USDA	1979-1980
Folman, Y.	Chief Scientist, MARD	1991-1995
Gomes, W. R.	Dean & Director ES, U IL	1992-1994
Halprin, D.	Budget Director, MIF	1984
Horn, F. P.	Administrator, ARS, USDA	1996-
Johnson, M.	Dean & Director ES, KS State U	1995-
Kinney, T.	Administrator, ARS, USDA	1983-1988
Levanon, D.	Chief Scientist, MARD	1997-
Loebenstein, G.	Director, ARO, MARD	1982-1985
Matthews, D.	Dean & Director ES, Utah State U	1987-1991
Mezainis, V.E.	OICD, USDA	1991-1994
Milgrom, D.	Budget Director, MIF	1997
Plowman, D.	Administrator, ARS, USDA	1989-1995
Pope, L.S.	Dean & Director ES, NM State U	1982-1986
Putievsky, E.	Director, ARO, MARD	1999-
Reed, W.	OICD, USDA	1995-
Sar, A.	Budget Director, MIF	1983
Sadan, E.	Director, ARO, MARD	1992-1994
Shalhevet, Y.	Director, ARO, MARD	1986-1989
Snapir, N.	Director, ARO, MARD	1995-1998
Vaadia, Y.	Hebrew University	1979-1991
Wallace, J.	Director, OICD, USDA	1982-1989
West, Q.	Administrator, OICD, USDA	1979-1981
Zusman, P	Hebrew University, Rehovot	1979

BARD 20-Year Review

Economic Evaluation of Selected BARD Projects

Executive Summary

USA
Virginia Polytechnic Inst. & State University

George W. Norton

Jeffrey Mullen

Israel
Zenovar Consultants:

Zvi Tropp

Michal Keynan

Asaf Cohen

An endowment and 850 funded research projects

The Binational Agricultural Research and Development Fund (BARD) was established in 1977. The budget derives from interest earned on a $110 million endowment plus supplement funds, contributed equally by the Government of the USA and the Government of Israel. BARD's mission is to promote collaborative agricultural research and development for the mutual benefit of both Israel and the United States. Over the past 22 years, BARD has financed nearly 850 research projects on a wide variety of topics. Many of these projects have made significant contributions to the body of scientific knowledge. They have furthered our understanding of genetics and biological processes, and developed new techniques for managing pests and information. Several projects have also had significant commercial and economic impact. The purpose of this report is to assess those impacts.

Ten projects selected for economic evaluation

To select the projects evaluated in this report, 520 completed BARD projects were first screened for potential commercial impacts. Those with the most promising and potentially measurable economic returns were selected for further evaluation. The BARD management conducted the first round of screening, reducing the project pool to 60. Subsequent discussions among BARD management and the U.S. and Israeli

economic evaluation teams reduced this set of projects to 25 and finally to 10. These final 10 projects were subjected to detailed quantitative evaluation. Information was gathered from project scientists, external scientists, and representatives of relevant industries, and a cost-benefit analysis was conducted. The result indicated that, together, these 10 projects are expected to generate an estimated $736M in economic benefits for the two countries by the year 2010. Table 1 presents the estimates for each project in each country.

Table 1: Summary of the Results of the Economic Evaluation (through 2010, US $M)

Project Title	US Benefits	Israel Benefits
Growth Stimulation and Improved Feed Efficiency by Feed Restrictions in Chickens and Turkeys	187	16
Knowledge-Based Information Systems for Dairy Herd Management	0.7	30.6
Optimization of Chromosome Set and Sex Manipulations in Common Carp, *Cyprinus Carpio* L.	Negligible	7.9
Aeration and Stirring of Intensive Aquaculture Systems	150	3.1
Determination of Carotenoids and Capscaicinoids in Chile Peppers and Paprika: Genetic, Physiological and Horticultural Aspects	Low	47.3
Introgression of Resistance to Northern Leaf Blight into Sweet Corn with the Sugary Enhancer Gene: A Genetic and Epidemiological Study	1.0	0.5
Molecular Approaches to Strain Development and Determination of Role of Specific Gene Products in Biocontrol by *Trichoderma* spp.	Low	2.2
Tagging Plants with Tightly Linked RFLP Markers	Too early to tell	33.2
Development and Testing of a Method for the Systematic Discovery and Utilization of Novel QTLs in the Production of Improved Crop Varieties: Tomato as a Model System	1.2	158.5
Selective Breeding of Farmed Fish	95.8	Not evaluated
Total	**436**	**300**

Economic benefits to the US and to Israel

Looking across the ten projects, the distribution of benefits between the two countries illustrates differences in the size of the relevant industry within each country, the preferences of their consumers, the propensity of their agricultural producers to adopt new technologies and the rate at which research results are converted to marketable products. It also reflects the different regulatory environments of the two countries. Each of the projects is discussed briefly below.

Poultry feed restriction improves profitability

The poultry feed restriction technology developed by BARD has been widely adopted by poultry producers in the United States, but less so in Israel. With the U.S. poultry industry valued at more than $21 billion in 1997, any efficiency gains in poultry production can have dramatic consequences – the expected U.S. benefits of this project were conservatively estimated to be $187M. The smaller poultry market in Israel, together with a lower adoption rate led to lower expected benefits. Nonetheless, the $16M in estimated benefits to Israel are considerable.

Information systems for dairy herd management

In contrast to the poultry project, Israeli dairy producers have been much more receptive to the information technology developed by BARD than have U.S. producers. This technology has created valuable efficiencies in Israeli dairy operations, but U.S. dairy farmers have opted for alternative production systems. As a result, expected benefits in the U.S. barely cover the cost of the project's budget, while Israeli benefits exceed $30M.

Sex manipulation and fish pond operation

The difference in benefits from optimizing sex manipulation techniques of common carp is due to primarily to consumer demand – U.S. consumers simply do not purchase carp. U.S. consumers do purchase catfish, however, and they have benefited from U.S. producers' near 100% adoption rate of the techniques developed by BARD for aerating catfish ponds. Israeli carp farmers have been slower to adopt the aeration technology, but are expected to do so in the future. Together, these two aquaculture projects are expected to generate $150M and $11M in economic benefits in the United States and Israel, respectively.

The US tilapia industry

The project concerning techniques for breeding tilapia was evaluated the United States, but not in Israel. These techniques have played an important role in the development of the small but growing US tilapia industry. This project is expected to generate nearly $96M in benefits by 2010.

Paprika-based industry in Israel

Neither the U.S. nor Israel is a major player in the world paprika market. The Israelis are expected to benefit substantially ($47M) from the chili pepper project evaluated for this report, while U.S. producers and consumers are not. The primary factor behind this is the project's use of paclobutrazol, a growth regulator. Paclobutrazol is not registered for use on food products in the United States, but is in Israel. As a result, the Israelis have been able to capitalize on the horticultural aspects of the project while their American counterparts have not.

Disease resistant sweet corn

The introgression of northern leaf blight (NLB) resistance into sweet corn cultivars is expected to generate modest benefits in both Israel and the United States. The difference in expected benefits between the two countries is due to differences in the incidence of NLB. Even though the incidence of NLB is higher in the U.S., it is not a major problem in sweet corn in either country. This is reflected in the relatively low expected benefits of the project.

Biocontrol of soil pathogens

The use of *Trichoderma* to control soil borne diseases is expected to generate limited benefits in both countries. This is due primarily to the fact that the out-of-pocket costs of the *Trichoderma* products are commensurate with chemical controls and their efficacy under field conditions is still being tested. This project could, however, generate substantial benefits if the chemicals for which it is a potential substitute were to face stricter regulatory measures in either country.

Discovery and selection of improved tomato varieties

There is a significant difference in the expected benefits to each country for the two projects concerning genetic markers in tomatoes. A tomato seed company, based on the know-how acquired in the first project, was

established in 1994 and produces the improved seeds in Israel. The company sells tomato seeds resistant to several important diseases in both Europe and Israel. A European strategic partner joined the company a few years ago. The company's value now surpasses $30M.

As a result of a second series of BARD projects, production of tomato seeds with improved quality and taste was initiated. The Israeli experts expect benefits of about $160M. The U.S. experts interviewed regard the value of these markers much more conservatively, around $2.5M. Their common refrain was that a lot of work has gone into identification of the markers, whose value to a U.S. commercial breeding program is yet to be evaluated. The expected U.S. benefits are discounted accordingly.

Estimated dollar benefits

Because the projects evaluated in this report were screened for their potential economic impacts prior to evaluation, the aggregate benefit estimates from the sample cannot be extrapolated to the entire population of BARD projects. Nonetheless, both countries have benefited considerably from these projects and many of the projects not evaluated certainly have positive commercial and economic benefits as well. Ignoring the potential benefits from other projects, the estimated $736M in economic benefits from these ten projects (Table 1) greatly exceeds the total discounted value of the investment in the BARD Fund since its establishment in 1979. It should be noted that this does not include the substantial benefits ($520M) derived from the five projects evaluated in the 10 year review of 1989. It addition, BARD has supported a significant amount of postdoctoral training, graduate students, workshops, international exchange and has contributed to the research infrastructure through the purchase of permanent laboratory equipment.

20 Year External Review

of

THE UNITED STATES – ISRAEL BINATIONAL AGRICULTURAL RESEARCH AND DEVELOPMENT FUND

BARD

Project Summaries (Annex)

Highlights of Scientific Achievements of BARD Funded Research

(1988-1998)

Table of Contents

Abstract Index

Introduction

As part of the 20 Year External Review of BARD, the Review Committee commissioned an assessment of the scientific and agricultural contributions and impacts arising from projects completed in the period 1988 to 1998. The assessment was based on the final reports from 520 completed projects and their peer reviews, routinely requested by BARD. Projects were rated by scientific merit and publication record. The assessment considered the scores, the written review, resulting publications and the final report itself. In addition, an evaluation of the benefits to agriculture of BARD funded projects was made, and are outlined in the report of the Review Committee.

For those projects assessed to be in the top echelon according to the criteria above, principal investigators updated the scientific summaries. These summaries are the content of this Annex. The projects are representative of activities in the spectrum of agricultural science supported by BARD. The summaries provide a synoptic account of the rationale for the work performed, the results obtained and the scientific impact of those results. In many cases the benefits of the collaborative nature of the project are indicated and the publications listed provide an understanding of the way in which the results have been communicated internationally. Some of those projects with patented intellectual property are indicated. The high standing in the scientific community of many of the investigators engaged in BARD projects can be recognized from their authorship of reviews or contributed book chapters.

While BARD is sometimes the sole funding agency of a given research program, in many cases there was additional support. The average BARD contribution to the "soft money" available to the projects was estimated by the participating scientists to be 67% (74% in Israel, 61% in the United States). In some areas it was higher (80% in agricultural engineering, soil science and postharvest science), and in others it was lower (60% in animal sciences). About 20% of the reporting scientists indicated that BARD funding was responsible for initiating a line of research that was subsequently also funded by other agencies. The Committee considers this catalytic role of BARD to have given added-value and significance to BARD's activities.

Conclusion

The Review Committee concluded that BARD supports research and development of high caliber and attracts submissions from many researchers who are recognized as being in the top echelon in their fields. The outcomes of these studies have improved agricultural production or provided an increased understanding of the basic processes underpinning it.

Methodology

Assessment of scientific merit (Figure 1)

Scientific merit scores of Outstanding, Excellent, Commendable and Poor were assigned to the 520 completed BARD-funded projects. The projects were screened according to the following criteria:

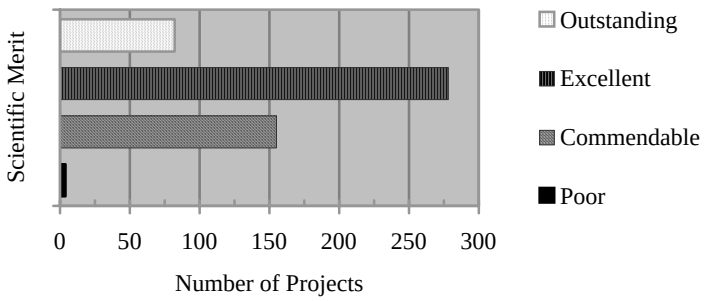
Outstanding: cutting edge, new ground, major contribution or breakthrough, prestigious publication

Excellent: solid, thorough research, interesting results, significant contribution to the field

Commendable: no scientific pretensions, essentially empirical, not particularly innovative but sound

Poor: poor protocol, sloppy, inconclusive.

Figure 1: Scientific Merit of Reviewed Projects



All outstanding projects and some of those classified as excellent are included in this volume. As part of the detailed evaluation, the relation of each project to other projects was noted. This includes *continuation* (C) or other closely related projects as well as "complementary" projects constituting a cluster dealing with different aspects of a central problem area or agricultural sector.

Assessment of Project Publication Record (Figure 2)

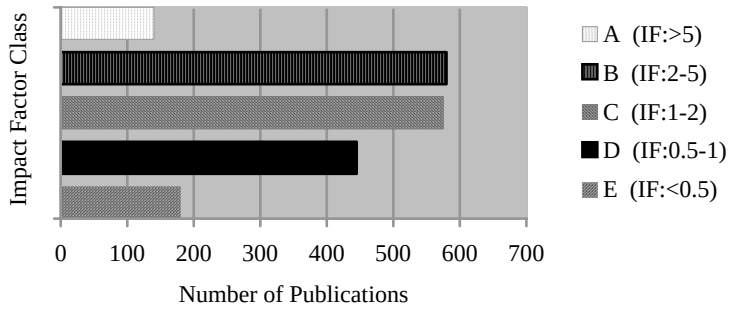
This assessment is based on the BARD publications database, at the time of the assessment, and includes a lists of 390 projects, totaling 1907 refereed papers. All refereed publications listed in the final report and entered into the BARD database were classified according to the 'impact factor' (IF) as published in the 1996 Journal Citation Record. These were then grouped by project into the following classes:

Class	IF	Description
A	>5	prestigious
B	2-5	high impact
C	1-2	moderate overall impact; very high impact for agricultural research
D	0.5-1	low overall impact; relatively high impact for agricultural research
E	<0.5	moderate to very low to impact

The publication record of each project was characterized by listing the overall impact score and, in addition, the total number of refereed publications.

The average number of refereed papers per project was 4.8.

Figure 2: Refereed publications, by Impact Factor



Key to the Abstracts:

Projects: Those BARD-funded projects which form the "cluster" of projects related to the summary abstract and carried out by some or all of the investigators identified. Matching superscript numbers following institutions and project titles identify participants with a specific project

Investigators: The primary US and Israeli scientists, and their institutional affiliation at the time of the BARD funded projects. Matching superscript numbers following institutions and project titles identify participants with a specific project.

BARD Project Number:

IS/US: The IS (Israel) or US (United States) at the beginning of the BARD project number indicates the country of affiliation of the principal investigator in the project.

4 digit number: an internal BARD project identification number

2 digit number: identifies the year of the submission of the project. Note that the initiation of the research is one year later than the submission year.

C, following the year, indicates that this project is a continuation of previously funded, related work.

Publications: These include those arising from BARD-funded projects , as reported by the authors, and in some cases from previous BARD-funded projects where the topic is related.

Note: The scope of the review includes projects which *concluded* during the period 1988-1998. This translates into projects *submitted* as early as 1984. In a few, exceptional cases, projects submitted *prior to* 1984 were included as part of the cluster to provide a comprehensive picture of the research accomplishments in the specific area.

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