->Terry Smutylo/Evaluation 4.4.1

86-1044-
88-1045
90-1031-
90-0001
→ 90-1005

EVALUATION OF PROJECTS IN EGYPT AND JORDAN

by

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RECOMMENDATIONS

As a result of work performed within the projects aimed to develop greenhouse film from greenhouse waste, both Jordan and Egypt now have groups of researchers with experience in the physics, chemistry, handling, processing and recycling of plastic wastes. IDRC has also contributed with pilot plant equipment that is now in place at the Royal Scientific Society (Jordan) and Mansura University (Egypt). IDRC should consider the additional projects to develop expertise in the region on general plastic waste characterization and recycling for applications other than greenhouse films.

The Foundry Sands project in Jordan has fully met its objectives. No further action is recommended in view of the evaluator's understanding that implementation of hard technologies is not contemplated by IDRC's present policies.

The Shale Brick project has dealt with and solved most of the problems associated with shale brick production and quality. There are, as expected, technical aspects that can be further refined. It is recommended that these be left to the consideration of the GOHBPR. Social and economic factors do not allow process and quality improvements to result in a better and cheaper product for the population of the region. It is suggested that working at the village level, through local organizations, may be the way to acomplish that goal.

CONTENTS

I.-SUMMARY AND CONCLUSIONS:

The Multilayer Polyethylene Film project/Jordan (86-1044) has been partially completed. Emphasis was made on studying the effect of composition on properties of films to be used as top or bottom layers of greenhouse film. Results are unsatisfactory and the report obscure and hastily put together. A coextruded film was produced for experimental purposes in Egypt. The reasons why the chosen structure, composition and processing of the film produced decided upon was chosen is unknown. The project falls short of determining an optimum composition and of developing a reliable product with a well defined technology.

The second Multilayer Polyethylene Film project/Jordan (90-1005) represents a second attempt to complete the development planned for in the first project. Again the new set of objectives have been only partially completed. Thorough field tests of the experimental film produced in the previous project were conducted. New film compositions were coextruded in a pilot plant set up for the purpose. The films obtained seem to have acceptable properties but have not been field tested. The researchers have generated a host of experimental data that have been used in a very ineffective way. The know-how accumulated cannot be called a technology and the films developed are unlikely to have optimal properties.

The Recycled Polyethylene Film project/Egypt (90-1005) has objectives which are similar to the Jordanian projects. They could also have been considered redundant if in Jordan the objectives defined had been met. As it is, the Egyptian project has also resulted in the generation of a large amount of data which has not been efficiently used. Much of the data presented in the report can be shown to be irrelevant to the process of optimizing the properties of the desired product.

The Foundry Sands project/Jordan (90-0001) is a textbook case of a difficult assignment being carried out with a clear, practical set of mind. The technical results are thorough and have been presented in the report in an exhaustive and easy to follow fashion. The impact of these results has been minimal, mostly because of the reduced size of the Jordanian market and changing economic conditions. Nevertheless the task completed has contributed to raise the the technical standards of the tiny Jordanian foundry industry and its results will be for them a constant source of reference.

The Shale Brick Production project /Egypt (88-1045) reports an extremely comprehensive study of the processing and properties of shale bricks. The project seems to be immersed in the wake of preceding research carried out by the GOHBPR. The objectives set forth can be considered to be thoroughly covered by the reports issued. Most of the effort seems to have been aimed to solve the problems of large brick plants rather than those of the small brick yards. The impact of the results reported have been minimal.

II.-OBJECTIVES:

As given by the terms of reference the objective of the work reported here reported has been to monitor and evaluate the following IDRC supported projects:

"...

1.-Shale Brick Production / Egypt (88-1045)
2.-Recycled Polyethylene Waste Film Applications /Egypt(90-1005)
3.-Multilayer Polyethylene Film / Jordan, Phase I (86-1044)
4.-Multilayer Polyethylene Fim / Jordan, Phase II (90-1031)
5.-Foundry Sands / Jordan (90-0001)

For the purpose of the evaluation, the following questions are to be addressed:

A.-Have the objectives of the project been completed?
B.-What were the results of the project?
C.-What has been the impact of the project?
D.-What further action should be taken to follow through on the results of the project?

In the addition to the above, the following issues are also to be addressed:

1.-e: Shale Brick Production / Egypt (88-1045)

The researchers have proposed a continuation of the work. Do the results obtained to date justify further funding by IDRC? Is it worth it? Are the results to date of interest to the poorest sectors of the population of Cairo and the region?

2.-e: Recycled Polyethylene Waste Films Applications / Egypt (90-1005).

$20,000 CAD has been budgeted in the Centre-administered portion of the budget for a workshop upon completion of the project. However, according to the project document, various steps were to be undertaken before the arrangements were made for the workshop (objective e, paragraph 34, a & b). Have these activities been undertaken?

If yes, the recipient is to submit a report to IDRC on these activities as well as the names of companies to be invited from interested countries and a detailed plan for the final workshop (focused on the demonstration of the technology, including a detailed cost/benefit analysis and the plans for technology transfer negotiation (booklets describing the technology, etc.)

III.-METHODOLOGY

"... you will be required:

a) to travel to IDRC's regional office in Montevideo to obtain copies of the various projects documents

b) to travel to IDRC's head office in Ottawa to consult project files and meet with Dr. V.S. Ramachandran, Project leader of the Canadian component of the Shale Brick Production (Egypt) project;

c) to travel to Mc Gill University in Montreal (either by bus or train) to meet with Dr. M.R. Kamal, Project Leader of the Canadian component of the Recycled Polyethylene Waste Film Applications (Egypt) project;

d) to visit the researchers, and other persons connected to the projects, in Jordan and Egypt; and,

e) to submit a detailed and satisfactory report of the work accomplished to the Director of the Environment and Natural Resources of the Centre by November 31, 1994.

..."

IV.-CONSULTANT'S AGENDA

DATE	FROM	TO	HERE	WHAT/WHO
July 21	Bs As	Montevideo	L.A.R.O.	File search
July 29	Bs As	Wash. D.C.		
Sept 5		Ottawa	I.D.R.C.	File search
Sept 6		Ottawa	NRC-Inst. for Research & Constr. I.D.R.C.	V.Ramachandran File search
Sept 7		Ottawa	I.D.R.C.	File search Salahma Fahmy Javier Verástegui
Sept 8		Montreal	Mc Gill Unv. Chemical Eng Dept.	M.R. Kamal
Sept 9		Ottawa	I.D.R.C.	File search
Sept 13		Wash D.C.	Amman	

IV.-<u>CONSULTANT'S</u> <u>AGENDA</u> (Continues)

	AMMAN	
Sept 15		
Sept 16	Jordan Valley & Highlands	Farms and Agricultural Communities
Sept 17	R.S.S.	Naseem Haddad Rami Khreis Nadia Khreis Yousef Tabaza Y. Abu-Hmeidan Presentations, discussions
	Modern Company for Machining & Metal Casting	Ali Ghasi Plant visit, discussions
	Sheba Metal Casting Co.	Mohammed Al-Zou'bi Plant visit, discussions
Sept 18	R.S.S.	Rosan Khadra P.R.
	Jordan Cooperatives Organization	Jamal Bdoor Promoting action
	Ministry of Agriculture	Walid A. Rabboh Promoting action
	Agricultural Plastic Industrial Co.	Ahmad Bitar Plant visit, discussions
Sept 19	R.S.S.	Said Alloush Naseem Haddad P.R., promoting action
	Intermediate Petrochemicals Ind. Co. Ltd.	A. Malek Said Reviewing their exper. with R.S.S.
	R.S.S.	Ramy Khreis Naseem Haddad Wrap up session

IV.-CONSULTANT'S AGENDA (Continues)

Sept 20		R.S.S.	Nadia Khreis Wrap up session
	Amman	Cairo	
	CAIRO		
Sept 21		M.E.R.O.	Carole Boud Eglal Rached
		G.O.H.B.P.R.	Hamdy El-Sayed Falthy Mosalamy Ali Sharara Ali Ayman Basil El-Sabbagh Mohammed Ramez Presentations, discussions, preparation of agenda
Sept 22		N.R.C. Polymers Dept.	Abbel Bary Abbas Yehia Yamir Botros Presentations, discussions, preparation of agenda
		National Plastics Co.	Mansour Rabbih Discussions, Industry stats.
Sept 23			Abbas Yehia Discussions
Sept 24		Trip to Delta Region	Basil El-Sabbagh Fathy Mosalamy Local Brick Yards
		Arab Medical Packing Co.	M. Farghali Industry info.
		Egyptian Packaging Development Assc.	Gamal Ghali Industry info.

IV.-<u>CONSULTANT'S AGENDA</u> (Continues)

Sept 25		Misr Brick Co.	Mohammed Nassar R.A. Bayormy Industry info plant stats
		G.O.H.B.P.R.	Discussions Visited Labs
Sept 26		Lasheen Plastics	Samy Mohsen Industry info
Sept 27	Mansura	Mansura Unv.	Abbel Bary Abbas Yehia Visited labs.
		Shoman Plastic Co.	Al-Sherbiny Shoman Visited plant, industry info.
Sept 28	Thabra	Sabry for Plastics	A. Sabry Visited plant, industry info. NRC discussions
Sept 29		Agricultural Research Centre	Adel El-Betagi Prot. Agr. stats.
		Egyptian Agricultural Exhibition	

V.-<u>JORDAN</u>

A.-<u>MULTILAYER POLYETHYLENE FILM-PHASE I (8~~4~~6-1044)</u>

1.-Have the objectives of the project been completed?

No, the objectives of this project have not been completed. As defined in the P.S., this project's objectives were the following:

a)-To develop multilayer plastic films by a coextrusion process...;
b)-To optimize the formulation and selection of ingredients and dimensions of each of the plastic layers on the basis of characterization and analytical studies carried out in the laboratory;

c)-To evaluate alternative manufacturing processes to select and design a complete system for manufacturing a coextruded...;

d)-To produce plastic films according to the indicated composition...using manufacturing facilities available in Jordan.

e)-To evaluate the performance of the films produced, using laboratory and field tests... and

f)-To transfer the developed film manufacturing technology to potential manufacturers in Jordan and surrounding countries.

Of these, only objectives a, b, c and d have been addressed to different extents by the researchers. The final report, deals almost exclusively with objective b.

The project proposal also includes a detailed and well thought out methodology to achieve the objectives listed. A comparison of results reported and of the "Methodology" section of the proposal shows the following:

"Development of the Bottom Layer"

15.-"...to obtain a detailed characterization of the recycled film..."--NOT COMPLETED--

16.-"...The average composition of the typical film waste available in Jordan will be identified on the basis of sampling.."--NOT COMPLETED--

17.-"..a virgin polyethylene or modified polyethylene resin will be selected..."--COMPLETED--

18.-"...alternative blending formulations will be prepared and evaluated..."--COMPLETED--; "...determine the most effective compounding process..."--NOT COMPLETED--

19.-"..blends will be produced and films manufactured for the evaluation of physical and optical characteristics..." --COMPLETED--.

20.-"Weathering behavior will be evaluated on the basis of laboratory and exterior exposure..."--COMPLETED--

Development of the Top Layer

21.-"...optimize the composition of the top layer ...u.v. stability ...determined by the resin characteristics, the additives and stabilizers.."--COMPLETED--

22.-"...alternative formulations will be evaluated..." --COMPLETED--

23.-"...weathering behaviour evaluated.."--COMPLETED--

Manufacturing Coextruded Films

24.-"...The multilayer film will be produced by a coextrusion technique..."--COMPLETED--

25.-"...a variety of films will be produced..."--NOT COMPLETED--

Evaluation of Manufactured Film Performance

26.-"...Manufactured, coextruded films will be evaluated..."--NOT COMPLETED--

27.-"...The physical, chemical and absorption spectra of the composite films will be determined..."--NOT COMPLETED--

Design of a Manufacturing System

28.-"...the main components of the manufacturing system will be designed and specified along with the recommended operating conditions..."--NOT COMPLETED--

29.-"...extensive field trials to determine the effect of the newly developed film on the development and maturity of crops..."--COMPLETED IN PHASE II OF THE PROJECT--

Training

30.-"...two engineers from the R.S.S. will spend 8 weeks in Canada..."--COMPLETED--

2.-What were the Results of the Project?

i.-Summary

As stated above, the final report deals almost exclusively with objective b. It is evident from the document that a lot of experimental work has been done at laboratory level. Unfortunately the process by which the conclusions were reached from the data reported is difficult to follow and the rationale for an eventual final composite film design is not shared with the reader.
Three lines in the summary section of the report inform that coextruded films were produced in Egypt. No explanation is given for the particular film composition chosen (which also goes unreported) and no description given of the manufacturing process used.

A more detailed discussion follows:

ii.-Experimental Design:

Objective a) recognizes the known fact that degraded polyethylene waste cannot be recycled into a product of specifications comparable to virgin material. The coextrusion technique allows a composite film to be manufactured so that virgin material is still the layer that is exposed to weathering. The protected underlayer is exposed only to the greenhouse environment. Its specifications are therefore less stringent, thus allowing for recycled material to be incorporated into its composition.

The standard to be met by the new composite film should match or exceed the performance of virgin film at a comparable cost. The properties of the final product which are of interest to service life are U.V. and I.R. absorption, visible light transmittance, and mechanical properties such as tear resistance, tensile strength and elongation. The melt flow index can be used to predict extrudability.

In this particular project (Phase I) the properties of films for use either as top or as bottom layers were investigated independently of each other. Varying film formulations for each type of layer were used as independent variables. Some selected properties of each film and the way they were affected by weathering were then determined.

INDEPENDENT VARIABLES

TOP LAYER FILM

- Stabilizer Type
- Stabilizer Concentration
- Weathering Time

BOTTOM LAYER

- EPDM Concentration
- Recycled Material Concentration
- Weathering Time

DEPENDENT VARIABLES

- Infrared Absorption at a specific wavelength
- Ultraviolet Absorption in the Range 200-400 nm
- Heat of Fusion
- Melting Temperature
- Elongation
- Tensile Strength

In the design of these experiments emphasis was made on the determination of structural damage of the polymer as such and not in the degradation of those properties of the film which affect its performance as a product to be used commercially.

How the information obtained independently for bottom and top films was used to optimize the composition and structure of the composite film finally chosen cannot be fathomed from the report's contents.

iii.-Bottom Layer

The carbonyl index was chosen to follow the effect of the independent variables on the oxidation of polyethylene. Total energy absorption in the I.R. range, the property of interest in greenhouse applications was not determined.

A simple model may be used to summarize the effects tested in the bottom layer experiments described in the report:

$$C.I. = Ao + A1*R + A2*W + A3*R*W^2 + A4*E$$

Where R is % of recycled polyethylene (PE) added, W is months of weathering and E is the amount of EPDM added. The A's are the corresponding effects on the carbonyl index C.I.

The C.I. also depends on other structural variables which the experiments could not control and did not deal with statistically, film thickness is one example.

The experimental results shown indicate a very slight effect of the amount of recycled PE added (A1) and do not show any evidence to suggest that A4 (effect of the amount of EPDM) is significant. Weathering time has a mild effect (A2) on the C.I. unless R is higher than about 50%. This last effect suggesting that oxidation accelerates at higher levels of recycled content R is described in the model by A3.

The experimental results therefore suggest that bottom film degradation as measured by oxidation can be minimized by keeping the amount of recycled material below 30%. The amount of EPDM added is inmaterial.

In spite of the results just discussed, the amount of recycled material that the researchers chose to use in the final composite film's bottom layer was 60%. No explanation is offered for having made this particular choice.

Results obtained for the effects of R (amount of recycled PE) and of EPDM are ambiguous. The raw data has not been reported and cannot therefore be re-analyzed. Nevertheless, the researchers do not seem to have been aware of statistical techniques available to discriminate between the effects of thickness from those of the independent variables R and EPDM.

As a consequence, no significant effects of R were detected and the effects of weathering time, W, were not quantified. Table V (page 51) of the report suggests that increasing EPDM concentration increases bottom layer UV absorbance. This leaves the designer free to fix EPDM additions according to considerations other than UV absorbance. No indication is given for the amount of EPDM finally chosen to optimize composite film properties.

Determinations of heat of fusion and melting temperatures as a function of the independent variables have not contributed significantly to the determination of bottom film composition. The weak trends observed are the ones expected of increasingly damaged films. Here again proper handling of the raw data may have resulted in significant, quantitative information, obtained in return for the extensive laboratory worked performed.

The determination of effects of the independent variables on the mechanical properties of the film are directly related to field performance. Their determination is therefore key in the effort to optimize composite film properties. The researchers recognize in their report the low quality of the mechanical properties data obtained. Nevertheless, given the vast amount of individual determinations made, a proper statistical handling of the results would have surely yielded quantitative, significant information directly applicable to film design and optimization.

As it is, the data plotted in graphs 5.1 to 5.10 suggests, and only suggests, that the 50% elongation at break criterion gives the bottom film an expected life of about 6 months for recycled contents of less than 30%. The conclusion of the report's author, that increasing levels of EPDM will stretch the useful life of the film beyond 9 months, probably stems from data or experience not included in the report.

In conclusion, the data presented seems to indicate that film degradation follows the expected pattern. It increases with increased exposure. Beyond that, little can be inferred from it on the effects of the amount of recycled material incorporated and EPDM on properties applicable to field life of the film, like UV absorption and elongation at break. Bottom films should not incorporate more than 30% recycled material nor should they be expected to last for more than 9 months on the field.

iv.-Top Layer

The main role of the top layer is to shelter the bottom layer from damaging U.V. radiation and to enhance the mechanical properties of the composite over those of the isolated bottom layer.

This issue is clearly recognized by the researchers. A considerable amount of data has been collected on the effect of stabilizer additions on UV absorption and elongation at break.

Here again the process by which the researchers go from the data reported to the rather diffuse set of conclusions presented is not clear to me.

Their analysis seems to suggest the use of Chimasorb 944 combined with Chimasorb 81 to a total of 1% stabilizer. The concentrations used in the coextruded film manufactured in Egypt are not reported.

3.-What has been the impact of the project?

The main impact of the project at the time of its conclusion seems to have been to justify its extension to a second phase. The reasons for this extension must have stemmed from considerations foreign to the original purpose of the project given the fact that most of its objectives were not completed and the poor quality of the report.

4.-What further actions should be taken to follow through on the results of the project?

This question has already been answered by the approval of the proposal for phase II.

B.-MULTILAYER POLYETHYLENE FILM-PHASE II (90-1031)

1.-Have the objectives of the project been completed?

Most of the detailed objectives have been formally met and the researcher has done a commendable job to follow step-by-step the methodology set forth in the proposal. Nevertheless, the general objective of the project has not been fulfilled.

The complexity of the problem coupled to the lack of adequate training in experimental design and interpretation of ensuing data has limited the actual accomplishments of the project.

The report clearly indicates that the researchers cannot handle multivariable experiments either in an efficient or effective manner. Their approach has been mostly intuitive and the report does not adequately reflect the amount of effort invested.

The review in the conclusions section indicates that the researcher has achieved a clear understanding of the issues at stake. Still, the product required (greenhouse coextruded film competitive with currently available products) is not there.

The proposal sets forth the following objectives:

8.-"The general objective of the present project is to produce in Jordan a new multilayer greenhouse film incorporating degraded and weathered films, with longer service life at a lower price than the films now on the market. This will be done by further refining on a pilot plant the technology developed during the first phase of the project."

This objective has not been accomplished. It requires the development of a marketable product. The plant coextruded films inherited from phase I have (as was predictable) a much shorter service life than existing monolayer films. Their eventual production cost is estimated to be lower but this prediction may not reflect in a lower price for the product. Lastly, I cannot agree with the notion that the previous phase of this project resulted in the development of a technology.

9.-"The detailed objectives are the following:

a.-"To produce a series of films on the RSS coextrusion plant;"--COMPLETED--

b.-"To evaluate the properties of those films in the laboratory and use that information to seek the best composition extrusion/parameters;"-- Formally accomplished-- I do not believe that the *best* parameters were found.

c.-"To investigate the field performance of multilayer films, particularly in regard to their performance as greenhouse covers". --COMPLETED-- This objective has been accomplished and I find the experiments were very neatly conducted. The limitation has been that they only had one coextruded film to work with (the phase I film, predictably deficient). The observation that the optical properties of the coextruded film during its limited service life and as measured by greenhouse productivity are comparable to those of the monolayer film is very significant.

d.-"To perform a feasibility study of the process" --COMPLETED-- The RSS has a special group (Economics Department) to conduct this kind of studies, they are responsible for the analysis reported.

e.-"To introduce the new technology to potential manufacturers in Jordan and abroad"--COMPLETED-- A workshop was used to meet this requirement. Workshops seem to be a tool favoured by IDRC, I do not believe they are effective. The objective has been formally met.

2.-What were the results of the project?

The main accomplisments of this project have been:

1.-It has been shown that greenhouses built using coextruded films containing recycled P.E. have crop yields similar to those of greenhouses using monofilms of virgin material;
2.-The RSS now has in-house expertise in film coextrusion and and the equipment to produce their own films for future development work;
3.-The researcher has reached a clear understanding of the factors that need to be controlled in order to develop a useful, competitive coextruded film. In particular the need to characterize the scrap material and the key role played by the top layer in protecting the bottom layer. This understanding has not been fully exploited. The temperature, induced degradation of the extruded film identified as a factor could have been easily controlled by water cooling the extruder screw.

It is clear that the investigator has not been able to handle the large number of variables and interactions involved. As a result, nowhere in the conclusions can the researchers state their results in quantitative terms or show that any of their films show optimal properties. In fact, as with phase I, it is not evident what the final film structure and composition should be.

In essence the whole exercise is aimed towards replacing virgin film with as thick a bottom layer as possible with as much recycled material in it as possible given field performance requirements and processing limitations.

As a result of the experimental work carried out, it should have been possible to answer questions like the following for any given film:

-what should the thickness of the top layer be if elongation at break is to increase by XX%?

-if the stabilizer contents of the top layer is raised by .X%, by how much can the thickness of the top layer be decreased without affecting the weatherability of the film?

-how many weeks of weathering are the equivalent of each percentage point of recycled material added to the bottom layer;

-etc.,

In addition, as part of the "technology" developed standards and procedures there should have been included:

-quality control of batches of waste material reaching the plant; sampling techniques, properties to be measured, levels for acceptance or rejection;

-quality control of semi-finished products;

-specifications for cleansing water, detergents;

-safety precautions in handling waste contaminated with pesticides and fertilizers; acceptable levels of these chemicals in water that has been recycled.

-standards for the finished product;

-etc.

3.-<u>What has been the impact of the project?</u>

The effects expected from the successful completion of this project are listed in the "Users and Beneficiaries" section of the project proposal (page 5):

"DOWNSTREAM EFFECTS: The main beneficiaries are intended to be the farmers...from a reduced price...because of the competition between film producers."

"UPSTREAM EFFECTS: The effect ...will be a decrease in raw material imports..."

"EMPLOYMENT CREATION:...due to an increase in sophistication compared with existing process..."

As measured by these expectations the project has been partially successful. As has been stated above the project's achievements have fell short of developing a coextruded greenhouse film product and its associated technology. Nevertheless the RSS has acquired a significant amount of experience on P.E. recycling. This experience includes:

-scrap characterization;
-improvement of scrap properties by addition of modifiers;
-scrap processing to produce single and coextruded films;

This experience is applicable to a host of film products that, although not as demanding as greenhouse film, are of equal economic significance.

The value of the researchers' contribution has been recognized by the largest film producer in Jordan, the Agricultural Plastic Industrial Company (APIC). In fact, from conversations with their general manager it became evident that this project has its origins in APIC's plans to build a recycling plant which date back to 1987.

It seems that APIC obtained the basic recycling technology from the suppliers of their equipment. In addition, they contacted the RSS for additional support from their scientists. In 1988, while phase I of the project was in full swing, they signed an agreement with RSS, the terms of which I did not ask about. Towards the end of 1988 the recycling plant was started up. At this point in time they make coextruded film for varied applications and have reached a recycled content of 40 to 60% "thanks to the input of the RSS..."

APIC is the largest film maker (40% of the market), the only one with coextrusion capability and the only large scale recycler. The basic figures used in the proposal for the economic analysis of the coextruded film project are still basically correct. On the other hand the assumption that lower cost of production will induce manufacturers to produce and sell coextruded greenhouse film has to be re-examined. Scientists think linearly, business people do not. In particular, recyclers will seek to minimize risk and complications and to maximize profit, not minimize prices. Why add a top layer to make a very demanding product when more money can be made out of selling bottom layer-like film products?

The consumption pattern of agricultural film in Jordan is the following:

mulch.......6,000 Tns.......~50%
greenhouse..5,000 Tns.......~40%
low tunnel..1,000 Tns.......~10%

TOTAL......12,000 Tns.

The estimate is that about 4,000 Tns (~30%) total scrap from agricultural applications are available for recycling every year. The rest is either burnt or buried. High quality waste from greenhouse films is probably half that much. The factor limiting the availability of waste material is mainly the lack of an established scrap market and of a collection and transportation system.

Black mulch film is used for only one season. Physical continuity and moderate mechanical properties are everything that is demanded from the film. Other applications of mulch type film include water conduits for watering and pond liners. Non agricultural applications of film require film specifications that are easily met: general covers and bags and packaging. Total demand for these applications may be estimated in about 10,000 Tns.

For as long as the agricultural waste film that is available for recycling is less than about 10,000 Tns, the plastic industry will choose to recycle all available material for applications less demanding than greenhouse film. Meanwhile they will choose to use virgin materials, even at a higher cost, to ensure reliable and constant quality of raw materials.

Against this background the project has helped at least one (large) recycler to produce better quality films with higher waste contents for applications other than greenhouse films. Although not quantified, it is reasonable to assume that part of the cost savings have been transferred to the consumers. Imports of raw materials must have also been reduced.

4.-<u>What further actions should be taken to follow through on the results of the project?</u>

Through both phases of this project the RSS have developed the basic information and have been provided with the equipment necessary to produce greenhouse waste into coextruded greenhouse film incorporating recycled materials. Coextruded greenhouse film containing recycled waste does not seem to be a viable commercial product. Still, the basic know-how developed is applicable to the general problem of recycling plastic waste.

Further action on this particular field must be left to Jordanians to decide upon. The scientific group at the RSS has not acted with conviction or determination in the application of the information that has been acquired. This has been due mostly to limitations in training and experience which are to be expected from scientific professionals rather than lack of will or enthusiasm.

Although there is no economic justification for recycling greenhouse film into greenhouse film, the countryside has to be rid of agricultural waste. It is for government to set up the necessary inducements to make scrap collection either economically advantageous or legally compulsory.

The economic climate in Jordan is very liberal within the constraints of their political system. Also, Jordan is a very small country where everybody seems to know everybody else. Building up a consensus through government action seems to be the best course of action coupled (maybe) with additional taxes to the importation of virgin raw materials as a further inducement to turn to recycling. Maybe a system like the one used in Germany (Please see Attachment # 1)

All that seems to be needed to get the ball rolling is a determined person that will champion the cause of recycling. This person needs not, and perhaps should not, be a scientist.

Government officials that I interviewed responded, at least while I was there, with enthusiasm and in some cases with immediate action. It would be very easy to make a significant contribution in Jordan that would set an example for neighbouring countries.

Regardless of the course of action chosen by Jordan, Nadia Khreis's idea of looking into solid waste management as a whole seems to me worthy of IDRC's attention. The main objective of such an undertaking would be to develop local expertise to back up decision making at the appropiate time (Attachement # 2).

C.-FOUNDRY SANDS

1.-Have the objectives of the project been completed?

Yes, all the objectives of the project have been completed in a most thorough and satisfactory fashion.

2.-What were the results of the project?

Very little can be added to what I consider a well thought-out, organized and clear report. The conclusions at the end of the report answer this question in a systematic and complete way. If the motivations for starting this project off in the first place are accepted at face value this project is, within my experience with IDRC, a textbook example of a job well done.

3.-What has been the impact of the project?

The impact of the project has been minimal in absolute terms. Nothing else could be really expected within such a short time frame and given the peculiar economic environment in Jordan.

The Sheba Metal Co. in Amman has, under the supervision of Dr. Khreis, incorporated the know-how developed in this project. The company produces 20 Tns/month of gray iron, steel and aluminun castings using local sands. Their sand imports from Turkey have been reduced from 400 to 130 Tn/ year while drastically reducing their rejects.

Most other foundries in Jordan received free copies of the "Sand Moulding Manual" prepared as part of the project's objectives. Many of the people running the smaller foundries are illiterate, but I found copies of the manual in two of the foundries that I visited.

The work done in the future may influence other foundry operations in Jordan. The know-how developed is now available from the RSS and the industry knows it.

One case in point is the foundry plant under construction by the Arab Engineering Industry. This is a multinational company, an Arab effort involving Jordan, Syria and Saudi Arabia which has been under way for ten years. The company will produce 7,000 Tns of castings per year with an annual consumption of 700 Tns of sand per year. I was told that the plant is expected to start production in 1995 and that the researchers involved in this project will play a key role in the technical management of the operation.

4.-What further actions should be taken to follow through on the results of the project?

No additional action is required.

VI.-EGYPT

A.-RECYCLED POLYETHYLENE WASTE-FILM APPLICATION (90-1005)

1.-Have the objectives of the project been completed?

The objectives set forth in the Proposal are (page 4, item 13):

a.-"To collect and characterize virgin waste film available in Egypt..."-

This objective has been formally accomplished, but the information developed is very limited and of little practical use. The purpose of this objective is, presumably, to determine what variability in the properties of the bottom layer can be expected due to the origin of the virgin material and the origin of the waste.

Only the mechanical properties of collected waste were determined. The researchers' conclusion is "...Their mechanical properties are practically in the same order...". This conclusion is incorrect. The significance of the data in Table 1 is not obvious. Not only large variations in strength and elongation are observed but the variations in thickness aliased to the sample origin tend to obscure the meaning of any correlations that the numbers quoted may indicate.

A more satisfying way of fulfilling this objective would have been to determine what are the variance contributions of manufacturer and site to the variance of waste properties and eventually of the bottom layer.

An interesting experiment to determine the effects of the variances would have been to expose films made by different manufacturers in different sites and then, accounting for the thickness, separate the variance contributions of manufacturer and site from sample and experimental errors.

Experiments like the one suggested are necessary to establish adequate standards for acceptance or rejection of waste to be used in bottom layers.

In order to determine whether any differences observed are or not significant a determination of the measurement error is at least needed, but has not been reported by the researchers.

In Table 2 of the report, variations in mechanical properties of the films are found from manufacturer to manufacturer. If the original data (provided by the researchers) for Homan Plastics films are considered then:

SHOMAN PLASTICS FILM PROPERTIES

	Strength MPA	Elongation %
	19.56	334
	17.82	435
	17.13	334
	21.17	426
	20.74	436
	20.65	471
MEAN	19.51	406.00
SAMPLE S.D.	1.53	52.81
POPULATION S.D.	1.68	57.85
Confidence Intervals		
63%	(+/-)1.7	(+/-)58
90%	(+/-)3.4	(+/-)116

Disregarding the effect of film thickness on strength and elongation we find from Table 2 that the overall means are (for Egyptian samples, longitudinal values only) 21.7 MPa for strength and 399% for elongation. The confidence intervals are:

	STRENGTH		ELONGATION	
60% INTERVAL	23.06	19.66	457	341
90% INTERVAL	24.76	17.96	515	283

The indication is therefore that significant overall differences between different manufacturers can be expected at the 90% confidence level. A similar analysis can be run for waste film properties.

b.-"To pelletize the films collected...and produce blends...optimize their formulation before and after weathering and evaluate their performance"

This objective has, in principle, been met. As it was remarked previously in connection with the Jordanian projects, the amount of experimental work carried out is staggering. Again, like in Jordan the researchers have only a rudimentary notion of design of experiments and of the techniques for interpreting the resulting data.

As a result, the investigators have developed in a very inefficient way, bottom and top films that meet a set of laboratory specifications and have combined them to produce a coextruded film that meets the same type of criteria. Neither the properties of the bottom nor of the top film have been modelled mathematically in order to optimize the composite film structure and composition.

Those top and bottom film compositions considered best have been simply combined in a scheme that provides only four combinations of top and bottom film. Thickness is pre-set instead of being considered another independent variable to be optimized. Resulting properties of the coextruded film are reported in Table 18. Although not stated in the report batches B1 and B2 correspond to M3 and M5 in Table 5.

A rough interpretatiuon of the results in Table 18 can be attempted in the absence of the original data. Focusing on the longitudinal strength only, an appropiate model for the response of the coextruded film would be:

STRENGTH = Eo + (E1xB) + (E2xT) + (E3xBxT)+ (E4xW) + (E5xWxT)

where:

B is the type of bottom layer, equal to 0 for B1 and to 1 for B2
T is the type of top layer, equal to 0 for T5 and to 1 for T12
W is the effect of ageing assumed linear as a first approximation

also:

Eo is the strength of the unexposed film of structure B1T5
E1 is the effect of changing the bootom layer from B1 to B2
E2 is the effect of changing the top layer from T1 to T12
E3 is the effect of changing from B1 to B2 when the top layer is T2
E4 is the effect of ageing for one hour
E5 is the effect of ageing for one hour with a T12 top layer instead of a T5

Using paired experiments we may estimate the values of the effects in the model. In order to find sample E1s, we substract strength values from samples that have B2 as the bottom layer from those having B1 in the bottom layer (top layer T=0 or T5) with everything else being equal to obtain the following values:

	DIFFERENCES			EFFECT	S.D.
E1 @T=0 :	0.2	0	1	0.4	0.43

That is, there is no indication at 63% confidence that E1 is not zero.

	DIFFERENCES			EFFECT	S.D.
E2 @B=0 :	0	-0.9	0.9	0	0.73

The same conclusion is drawn for E2.

In the same way, it can be shown that there is no indication in Table 18 that any of the effects shown are significant. In fact, when pooling values of strength for all coextruded film structures the value of the only significant effect in the model, E4 the effect of ageing, may be found.

The conclusion is therefore that as far as tensile strength goes, the structure-composition combinations of coextruded films examined are all equivalent.

More information is available from Table 19. The model here should be extended to include exposure site and E4 would now represent the effect of weathering for one day, assuming again, for this purpose, linear effects. A multivariate analysis of variance of the data in Table 19 indicates, at 90% confidence level, that:

1.-There is no indication that any combination of top and bottom layers have any influence on longitudinal strength;
2.-There is no indication that changing weathering sites affects the final strength;
3.-Final strength is affected by time of weathering but not by weathering site;
4.-The nature of the top layer affects final deformation, the nature of the bottom layer does not;
5.-Weathering affects deformation in a way that changes for different weathering sites;

These conclusions are valid only within the ranges of the independent variables defined in Table 19. Some of these conclusions can be quantified in order to describe film properties within or slightly outside the experimental range. Multivariate regression shows the following significant relationships:

STRENGTH= 16.5 (+/- 0.3) MPa - 0.005 (+/- 0.001)(MPa/Day) * W

ELONGATION= 533 (+/- 7) % - 0.39 (+/- 0.04) (%/Day) * W

The maximum weathering period reported is 335 days, for which the ELONGATION model predicts:

395 +/- 32 with 90% confidence

regardless of the nature of top or bottom layer and weathering site.

In the same way we may now ask ourselves how long the film will last for before its elongation falls below the half its initial value:

$$533 \times .5\% = 533\ (+/- 7)\ \% - 0.39\ (+/- 0.04)\ (\%/\text{Day}) \times W$$

we find that the model predicts a expected durability of 23 months with an uncertainty of about 4 months either way at 90% confidence. This is to say that the film is predicted to last for 19 months with 90% confidence.

The calculations presented for the sake of illustration are intended to show:

1.-That the coextruded film product cannot be considered an optimal product even if it meets a set of minimum properties and

2.-That it would be very much worth the effort to review the original data with the help of a person familiar with data handling and experimental design.

c.-"To conduct industrial trials for coextrusion production and evaluate the performance of the films produced before and after weathering;"--NOT COMPLETED--

d.-"To perform a feasibility study of the developed technology and to carry out field tests of the films made in c)";--PARTIALLY COMPLETED-- The feasibility study presented is really a cost analysis and it falls short of being a commercial feasibility analysis. No field tests where conducted because there were no plant produced films to test.

2.-<u>What were the results of the project?</u>

The main accomplishments of this project have been to:

1.-To introduce a group of trained professionals to the problems of plastic waste recycling;
2.-To provide equipment for the development of recycled plastic waste into film products;
3.-To develop a group of coextruded films that exhibit in the laboratory and some limited field tests properties which might render them appropiate for use in greenhouse applications.

The main drawbacks have been, as was the case in Jordan:

1.-The researchers do not have the feeling, the ability, the need or the experience for pushing a tecnologically (semi or totally) proven product into commercial production. As a result, no commercial operator or state organization is aware of the potential product being developed. For this and eventually for reasons independent of the researchers nobody has expressed the least interest in their potential product.

2.-It is clear that the investigators have not been able to handle the large number of variables and interactions involved. As a result, nowhere in the conclusions can the researchers state their results in quantitative terms or show that any of their films show optimal properties. In fact, it is not evident what the final film structure and composition should be.

Other remarks made in discussing the question of results for phase II of the Jordanian Project apply equally well here.

3.-<u>What has been the impact of the project?</u>

The project has had no impact whatsoever and I do not expect it to have any in the medium term, unless people with complementary training and experience and different attitudes are brought to bear.

During discussions concerning the right and timely way of delivering the know-how developed to industrial operators I always asked the researchers: Who is interested in what you are doing? and if a name was brought up then: How many dollars have they spent backing you up?

In this case the one and only answer was Shoman Plastics for the first question and to the second that they had helped preparing the pellets for some of the experiments.

What was not mentioned is that Shoman Plastics obtained from the resarchers a $25,000 piece of business, against which the contribution of a few hours of machine time was just a reasonable expense to be charged to public relations.

As for their interest in the product, I proved to my satisfaction that the general manager of Shoman Plastics did not have the least idea of what the researchers had been doing in their plant. He only knew he had sold them a machine.

Even if the researchers had made a good show of advertising their product-to-be, it is not obvious that the industry would have shown any interest in it. In Egypt, as in Jordan but for somewhat different reasons, recycling for greenhouses is not yet attractive and may never be.

I do not have precise figures for total polyethylene and film consumption in Egypt. They were promised to me by a number of company and government officials but never delivered. The figure of 8,500 Tns/yr quoted by the RSS in their study (89-2022) seems very low given that Jordan, with 1/10th of the population, consumes as much. Also, considering some incomplete data on the output of the largest film manufacturers in Egypt:

1.-Medical Packing (public)....extruder x 12 mts......
2.-National Plastic(public)....coextruder x 4 mts.....6000
3.-Hyma Plastic.(private)......extruder x 14 mts......6000
4.-Horia Plastics (private)....coextruder x 7 mts.....
5.-Shuman Plastic.(private)....coextruder.............5000
6.-Lasheen Plastics(private)...extruder...............2500

and the fact that National estimates their share of the market at 30%, I'll take 25,000 total film production as a rough estimate.

To estimate total agricultural film I made use of figures provided by the Agricultura Research Centre.

Total greenhouse................1,250 Htrs (5,000 in Jordan)
Area of one greenhouse tunnel... 540 m^2=.054 Htrs
Weight of film per greenhouse... 200 Kgr
Total greenhouse film...........5,000 Tns/yr

On the other hand:

Total low tunnel area.............25,000 feddans or 10,500 Htrs
Average weight of film per tunnel...400 Kgr/feddan or 950 Kgr/Htr
Total low tunnel..................10,000 Tns/yr

To this total of 15,000 Tns of film for agricultural film a few thousand Tns (about 6,000 Tns sounds right) should be added to account for mulch and then the total figure should be multiplied by a factor of two to account for packaging applications. A total estimate of 25,000 Tns per year for total film consumption seems about right.

Focusing now on recycling, there are about 25 recycling plants in Egypt. Their typical equipment allows for a capacity of 300 Tns/yr for a grand total of approximately 8,000 Tns/yr recycled in Egypt.

To summarize the coarse estimates developed above:

Total film production.......25,000 Tns
Total greenhouse............ 5,000 Tns
Total recycled...............8,000 Tns

As argued in the case made for Jordan, there is no reason to recycle low quality greenhouse waste into highly demanding greenhouse film if:

1.-There is an unsatisfied market for less demanding applications as the figures quoted seem to indicate;
2.-There are easily accesible sources of high grade waste, like medical packaging which is easily collected from hospitals;

In fact, recyclers will do their utmost to process the highest quality material. In spite of the fact that one particular recycler (Sabry) expressed that he could get his hands on as much waste as he could process, he chose to import plant scrap from Algeria for some of his own products rather than face the uncertainty associated with hand classified waste.

While virgin material prices are on the rise and supply scarce, recyclers have no incentives to upgrade the quality or sophistication of their products. Waste recycled at a cost of 600 Egyptian pounds (LE) is sold for 3,500 LE, and recyclers are working at capacity.

Another factor to be surmounted (and this applies to Jordan as well) is the fact that consumers have a low perception of recycled materials. They are equated to re-processed garbage and valued as such.

4.-What further actions should be taken to follow through on the results of the project?

It is not clear to me why this project was approved by IDRC in the first place. It essentially duplicates work that had been done or was being carried out in Jordan. If the Jordanian RSS had developed a good greenhouse film then the way to proceed would have been to run weathering and field tests in Egypt.

The experimental data generated during the course of the project should be re-analyzed. Using appropiate techniques I have no doubt that much more information can be obtained and a better final product defined.

As it has been the case with Jordan, through this project the NRC and the University of Mansura have developed the basic understanding and have been provided with the the tools necessary to develop and produce greenhouse waste into coextruded greenhouse film incorporating recycled materials. The basic know-how acquired can also be applied to the general problem of recycling plastic waste.

The Egyptian researchers have shown the usual lack of understanding of the ways of the business community. In addition, Egypt is different to Jordan in a number of ways, and none of those differences promote innovation at any level.

The economy is still tightly controlled, the largest operators are owned and run by the state, the industry is oligopolic. Bureaucracy and red tape permeates everything even the minds and the culture of individuals.

In the scientific and academic environment there are no incentives, financial or other, for the development and application of commercially valuable know-how. On the other hand, securing a subsidy or grant from a foreign organization provides both personal and institutional income and personal prestige.

I assume that the motivations that justify the funding of the original project still stand and that emphasis is on the application of the information developed rather than on furthering of research capacity.

That being the case, and as the issue of solid waste recycling is of the greatest concern for ecological, health and economic reasons, further support of a related project would be recommended. The researchers should obtain the support of a private concern or individual. I do not think that a public organization would do in the case of Egypt. This support should include sharing the risk of development and commercialization of the product or process of interest. It should be materialized through a financial contribution to the project, in cash, of an amount at least equal to the grant requested from IDRC.

5.-Workshop

The know-how developed cannot be called a technology. The basic mechanisms for the control of material and product properties are understood but have not been properly quantified in a systematic way; the product has not been optimized; field tests have not been conducted; it is not evident that a reliable product of constant properties can be manufactured from waste material; a methodology for characterizing waste films has not been developed; the structure of the supplier-recycling industry (formal and informal) has not been studied; standards for semi-finished and finished products have not been developed; a production manual describing the manufacturing process and specifying production parameters is not available, etc.

Under these circumstances it is not reasonable to expect that "technology transfer agreements will be initiated..."(paragraph 34,c of the proposal). If they were, I do not think that a person has been enlisted with the capability of, or empowered to, negotiating such kind of agreements.

The "Provisional Program" for the workshop is included as Attachment # 3 It is irrelevant, essentially an exercise in public relations that "...will assist in experience exchange and enrich the second phase of the project..." (paragraph 3 of Attachement #4 I definitely think that it is not worth it.

B.-SHALE BRICK PRODUCTION (88-1045)

1.-Have the objectives of the project been completed?

All objectives, down to the detailed objectives set forth in the methodology section, that do not require extensive work outside laboratory facilities have been met. Laboratory work has been extensive and thorough. A solution has been found for all of the problems associated with the use of shale. Activities designed to test laboratory results under production conditions have not been carried out.

2.-What were the results of the project?

The basic problems to be solved were related to processing and final properties. Given that shale must be used: How to obtain a workable material that will not abrade or corrode the machinery and yield a brick with acceptable properties?

Shale requires more water than Nile silt. To reduce shrinkage sand is added. Sand abrades machinery. Silt also contains chloride salts which corrode machinery, promote efflorescence and are exhausted with the kiln fumes.

The work reported has addressed these issues and found working laboratory solutions for all of them.

Plasticity and shrinkage have been found to be reduced by adding acetic acid (1.5% recommended); sand can be replaced by grog or finely milled limestone powder; pre calcining the shale also reduces the amount of chlorine in the brick (although the total amount exhausted into the atmosphere is the same). Limestone additions seem to be the best method, they also allow for lower firing temperatures to be used. A more complete summary, as given by the report's authors is enclosed with this report as Attachment # 5.

3.-What has been the impact of the project?

I estimate that the project has had no impact on the small scale brick manufacturers or amongst the low income population in the area. A discussion follows:

When considering the work recorded in the reports resulting from this project it is interesting to keep the chronology of events in mind. The following information was collected from varied formal and informal sources.

In 1969 the GOHBPR was given the mandate to look into shale as the replacement of silt in brick production. Research was started in 1972. In 1976 the GOHBPR obtained a grant to support their shale research from the Austrian government. The use of Nile silt for brick manufacturing was forbidden by a law passed in 1978. Brick manufacturers were given until 1984 to switch over to shale. By 1982 the first plant trials were conducted by GOHBPR.

In 1988 the present project proposal is approved. The general objectives of this proposal are sufficiently basic that it is reasonable to assume a considerable amount of redundancy with work done previously by the GOHBPR. Some of the answers to the questions set forth in the proposal must have been already available after 12 years of research into the subject.

As a consequence of the prohibition of 1978 the number of small (10-15 million bricks/year) brick manufacturers decreased from over two thousand down to about half that number in 1988 and then to the present level of about 800. On the other hand, there were 10 large (200 million standard bricks/year) publicly owned and operated of which only one remains.

The causes for these casualties are different for the case of yards than for the case of large plants. The yards that went under did so mostly because they could not adapt to using shale as a raw material. They did not have shale available near the yard or could not afford the additional investment in machinery (extruders were not needed with silt) or simply did not learn in time how to handle the shale.

On the other hand, most of the large plants were installed after 1978 under turnkey agreements with foreign suppliers to use specifically shale as a raw material. The reason for their failure to survive is that more recently the government has stopped subsidies to publicly owned companies. Large operations could not compete in price with small yards.

I visited the sole, surviving large plant. The Misr Clay Brick Co. has its plant in the industrial center in Gazra, in the southern suburbs of Cairo. The plant was constructed under a turnkey agreement by the French and started up in 1982 at a cost (I estimate from the information given to me that it was 30 million LE in 1982) of twenty million US dollars. The plant is fully automated and uses stainless steel lined, forced convection stoves and furnaces for pre drying and firing of the bricks.

The plant manager told me that they are barely breaking even and he obtained from their financial department a % cost distribution. Their sales people informed me that they sell standard bricks at 100 LE per thousand bricks. It is reasonable then to estimate that their total cost is equal to the selling price. With this information the following costs can be estimated:

PLANT CAPACITY	200	million bricks/year
TOTAL COST	100	LE/1000
Labor (25%)....	25	
Raw Materials(n	0	
Energy.........	40	
Maintenance....	19	
Supplies.......	3	
Depreciation...	13	

Total investment can be calculated back from here to check on the assumptions:

Investment = (20 yrs x 200,000,000 bricks/yr x 13 LE/brick)
= 52 million LE = US$18 million.

which agrees reasonably well with the original estimate of US$20M. It amounts to US$ 0.10 of investment per each brick of yearly capacity.

The total number of workers is 500, therefore the cost per worker is 200 M bricks/yr x 25 LE/(1000 bricks) / 500 workers = 833 LE per worker.

Similar calculations can be made for the tipical small brick yard (Please see next page):

Some interesting observations can be now made from the perusal and comparison of the cost structures of large and small brick manufacturing operations.

The first observation is that household income for the family operating the yard is about US$1100 per month. This has to be compared with US$300 for an engineer with a Ph.D. and 30 years of experience working with the GOHBPR, or the basic salary of a Ph.D. with the NRC (US$200), the take home wages of a worker at the large brick plant (US$180) or, finally the take home wages of a worker in a small yard (US$60).

Next we see that the most important cost items for a large plant operating next to the shale deposits are ENERGY, followed by LABOR and MAINTENANCE. From the conclusions of the project summarized above or from Attachment #5, we notice that the principal "achievements" of the work done are: reduction of sand contents (reduces erosion, therefore MAINTENANCE), control of chlorine emmissions (reduces corrosion of fans, s.s.linings, therefore MAINTENANCE), adding ground limestone (MISR is very close to at least one lime plant and their RAW MATERIALS cost is nil) reduces firing temperature (reducing ENERGY costs) and improves quality.

Now quality is mainly a concern of the large operator. Most of their sales are to other public organizations or construction "consultants" which manage construction of large private buildings or private houses for the wealthier classes.

LABOR costs cannot be reduced because large operations must comply with government wage regulations and are closely watched by the unions.

COST STRUCTURE OF A TYPICAL BRICK MANUFACTURING YARD

CAPACITY	14	million/yr	per 1000 bricks:
INVESTMENT			
Land	4,140	LE	
Machinery	200,000		
Stack/furnace	60,000		
Water Tank	10,000		
Transformer	190,000		
Total Mach.&Equip	460,000		
Depreciation	15	yrs	2.2
DIRECT COSTS			
Raw Materials			
Shale	12	LE/m^3	
Sand	8	LE/m^3	
		(2 m^3/1000 u.)	21.6
Labor			
Firing crew	400	LE/week	1.5
Contractor	20	LE/1000 u.	20.0
Loader/Driver	25	LE/hr (2 hrs/day)	0.1
INDIRECT COSTS			
Maintenance	18000	LE/yr	1.3
Electricity	4000	LE/month	3.4
Fuel	135	LE/Ton (14 lbs/1000	0.1
		TOTAL COST/1000 U.	50.2
		add 15 % rejects	55.2
		Selling price ex-yard	90
		Profit before taxes	34.78
		Profit after taxes	28.52

TOTAL REVENUES FOR THE YARD	1,260,000	LE/yr
	420,000	$US/yr
TOTAL NET INCOME FOR THE YARD	399,262	LE/yr
	133,087	$US/yr

Total investment is therefore US$.01 per each brick/yr of capacity.

On the other hand the main cost items for a small operator are RAW MATERIALS and LABOR, while the cost of ENERGY is insignificant, mostly because the bricks are naturally dried. The yard operator would therefore not be interested in increasing RAW MATERIALS cost by adding limestone, or decreasing ENERGY costs. Nor would they be interested in improving quality beyond what present levels because they customers are mainly local, for small dwellings where are not highly stressed and nobody controls their quality.

Now quality control is the responsibility of the GOHBPR and they have not developed national standards for bricks or their raw materials and they never inspect yards to test the quality of their production.

I only visited three yards, chosen by my GOHBPR hosts. I was told by the yard managers that they had seen my sponsors once some years ago during the first licensing inspection, later accompanying another foreigner and then with me. I asked point blank to one of the managers whether he had received any technical help from GOHBPR and he look dumbfounded.

Yards have learnt to use shale by consulting with the suppliers of the mixers and extruders, by bringing in foreign consultants (a Yugoslavian expert was mentioned) or by spying on each other or word of mouth. The GOHBPR was never mentioned as a source of know-how.

What they do to decrease salt content (gypsum is also a problem) is to wash the shale before feeding into the mixer. I dipped my fingers into a puddle of water that had drained from the shale and took it to my lips. It was very, very briny.

The shrinkage problem is somewhat ameliorated by the fact that extruded bricks are slowly dried outdoors. The bricks are transported using donkey charts to the yard where they are piled up in rows and covered with hay or sheltered under roof. After 5 to 7 days the straw is removed, after an additional week the bricks are rearranged. This slow process at low temperature partly avoids the problems arising from the higher temperature, forced convection drying in large operations. It also decreases the need for decreasing the sand content and minimizing water additions. Yards do not operate during the cooler winter months.

To summarize: There has been no impact of the project on the small yards nor has it had any effect on the prices of bricks available to the general population of the region.

4.-What further actions should be taken to follow through on the results of the project?

Small yards are very cost efficient operations. The GOHBPR has presented a proposal for extension of the this project Attachement #6). The GOHBPR has all the technical knowledge that is required to answer any specific need that may be identified. The GOHBPR is not at this point in time, the right organization to address the needs of yard operators. Any isolated action taken to improve the quality or cost of the operations will translate into higher income for the owners rather than in cheaper bricks for the poor.

I believe that the only way to benefit the population at large is to take this matter to local organizations. A more detailed discussion of this proposal should include an Egyptian national. To avoid embarrassment and friction in dealing with villagers it is necessary to feel comfortable with the culture and to be knowledgeable in their ways. The owners of the yards, their families, the workers, truck drivers all belong to the same community. In order to explore effective ways to increase yard efficiency in a way that will result in cheaper and better bricks, the dynamics of the community has to be thoroughly understood.

5.-The Researchers have proposed a continuation of the work. Do the results to date justify further funding by IDRC? Is it worth it? Are the results obtained to date of interest to the poorest sectors of Cairo and the region?

It is evident that, be it by design or by chance, the experimental work has been mainly designed to solve the problems of the large operators.

The fact is that the principal researcher in this project is also a member of the executive committee of a brick manufacturing company. Most likely MISR itself. MISR is at the brink of closing operations because it cannot produce bricks in a cost effective way.

The Ministry of Reconstruction owns the plant, but I can see that there must be a lot of pressure on the Ministry of Housing and therefore on the GOHBPR to come up with ways to decrease maintenance and fuel costs.

The GOHBPR has the necessary equipment, the brain power and the expertise to solve any and all the problems associated with large or small scale brick production. I was in fact amazed to find such a concentration of Ph.D.s with expertise in so many associated disciplines.

On the other hand walking through the laboratories it was obvious to me that their equipment had gone untouched for months. I noticed a person running ahead of me shaking the dust off mixers and extruders while I walked the laboratories.

I do not recommend further funding of any research project through the GOHBPR. If they are motivated they can secure funding from their own budget or from the small yards (a US$100 million industry).

It must be noted that the GOHBPR is the institution responsible for: inspecting the yards and plants and to certify that they use only shale, make adequate use of land space and meet other government standards. They can close any yard that they find at fault, so it is not because of lack of authority that they do not get the attention or collaboration from small yard operators. I believe is lack of interest.

"Packaging a Revolution"

(September/October 1993)

World Watch reported last year on Germany's revolutionary—though imperfect—efforts to make manufacturers responsible for the collection and recycling of their packaging after it is discarded by customers.

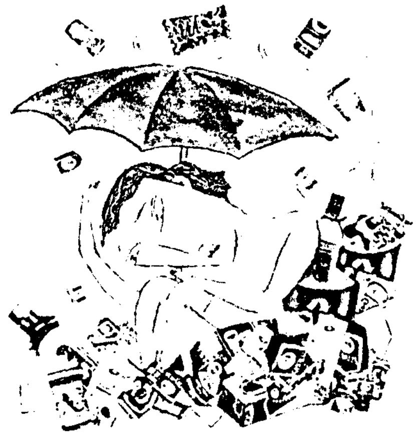
At that time, the German system faced a precarious financial situation generated by its original fee structure. Initially, manufacturers were charged a weight-based fee for the packaging materials they used (the fees are to cover the cost of collecting and recycling the packaging). Although the system was able to find recycling markets for paperboard and glass, it soon ended up with a glut of plastics and composites, which are much harder to recycle. So it moved to a sliding fee scale, based on material *types*, rather than just weight, charging manufacturers more for plastic and composites than for paperboard and glass. This October, the fees will be further differentiated so that a ton of plastic will cost almost 20 times as much as a ton of glass.

As a result of the shift to a more accurate fee structure, Germany's system is now on more solid financial footing. The total amount of packaging in Germany decreased by 4 percent in 1993, from 12.3 million tons to 11.8 million.

More important, perhaps, is the shift in the types of material used for packaging in Germany. Plastic has lost one-third of its market share to paperboard and glass, according to Joachim Spangenberg, researcher at the German government's Wuppertal Institut. For every ton of plastic sold for packaging in Germany now, two-thirds of the cost stems from its collection and recycling fee and only one-third is generated by the plastic itself.

Although the shift to packaging that is easy to re-use or recycle is incomplete, Germany is seeing "the first indication of what it would mean if prices told the ecological truth," says Spangenberg.

As Germany continues to adjust its system, the European Union is working toward common recycling standards for its 12 member countries. Such legislation is important because there has been some tension between member nations over various packaging schemes. The German



system, for example, although effective in collecting large amounts of packaging materials, flooded the recycleables market—lowering the price for recycleables elsewhere in Europe.

The legislation sets both minimum and maximum targets for materials collection and recycling—it includes maximum limits because the current market can only use so much recycled material. The European Union legislation does offer an exemption to the maximum if countries are able to prove that they have enough domestic recycling capacity to collect and use a higher percentage of materials.

—*Megan Ryan*

Can Money Buy a Longer Life?

(November/December 1993)

While most of the world's life expectancies have been rising consistently, the lifespan of the average citizen of Russia is decreasing, as noted in *World Watch* late last year. Recently released data on this counter-trend now indicates that the downturn is even larger than previously thought, and may be worsening. In 1993, 20 percent more Russians died than during the previous year, and Russian researchers now believe that the life expectancy for men is down to 59 years, a rate 15 years below typical lifespans for the industrial world.

Heart and circulatory failure was the leading cause among the additional deaths reported, accounting for about half of them. Although health authorities would typically address increased death rates related to medical problems, the number of heart and circulatory-related deaths was so high that it was considered to be a matter of national security as well.

The second leading reason for the increased mortality figures is an increase in violent crimes, which were responsible for a quarter of the added deaths in 1993. Social crisis, personal insecurity, and economic hardship are thought to have played a big role in that violence.

For Russian women, life expectancy is now 73 years, also below recent levels. The difference between life expectancies of Russian women and men is the largest of any country.

In 1993, 1.4 million people were born in Russia and 2.2 million died. Taking into account migrations to Russia from other former Soviet republics, the net fall in Russia's population was half a million.

—*Hal Kane*

FROM :

ILLUSTRATION BY CYNTHIA CAROZZA

AN APPROACH TOWARDS SOLID WASTE MANAGEMENT IN JORDAN : PLASTICS AS A CASE STUDY

Proposed by: Nadia Khraishi
Royal Scientific Society
P.O.Box 925819 - Amman
JORDAN

BACKGROUND

Issues relating to disposal of waste in general and of plastics in particular are a major concern worldwide. The rising environmental awareness has forced governments and local authorities to search technical and organizational solutions for a future-oriented waste management.

Various legislative initiatives and procedures have been activated within the past few years in the leading industrial countries aiming at encouraging reduction of the waste produced and increasing reuse and recycling of waste components.

On the other hand, the developing countries are still far away from recognizing an environmental strategy which controls and regulates the disposal of the different waste streams. The low priority given to waste management in the developing countries leads to the loss of a lot of precious raw materials and to the deterioration of nonrenewable environmental resources such as air, land and water . The welfare of future generations is strongly related to the sustainability of the resources existing today.

The economic disadvantages from the abscence of a waste management policy is also clearly recognized , particularly in the developing countries where raw materials are mostly imported thus constituing a strain on the national budget. Jordan for example spent 20 million Jordanian Dinars(JD) on a single type of plastic raw materials on 1992, namely polyethylene. The total imports of artificial resins and plastic materials were 71.65 million JD on 1992 . Imports of selective raw materials on the year 1992 were ;

Plastics	71.65 million JD	(1JD = 1.3 US$)
Rubber	32.14 million JD	
Paper and paperboard	50.02 million JD	
Paper making materials	3.29 million JD	
Iron and steel	163.37 million JD	
Copper	8.36 million JD	
Aluminum	15.83 million JD	
Zinc	1.30 million JD	

If a recycling of 20% of the plastic,rubber and paper raw materials and a recovery of 10% of metals were achieved in response to a set modest target of a well-defined national environmental strategy, the total savings in the foreign currency reserves is estimated to be about

50 million JD or 73 million US $ annually. This rough estimate of saving could rise significantly if imported finished products are included rather than raw materials only.

Researchers from the Royal Scientific Society (RSS) in Jordan have recently completed a two phase project supported by IDRC on the recycling and utilization of agricultural plastic wastes. The results of this project have proved beyond doubt that waste recycling and its utilization via complementary state-of-the-art technologies offer a very attractive solution to nuisance environmental problems and improves the economics of production. However, the major obstacles that limit the full nation-wide implementation and realization of the findings emanating from this research are the absence of a reliable system of waste recovery that gaurantees the continuous supply of classified scrap materials to the local relevant industry as well as the lack of education and motivation among individuals to justify a waste recovery system that would essentially require their efforts and willings in order for such a system to succeed. Also the spectrum of market opportunities for recycled materials and products have not been explored yet at the national and regional level.

Therefore comprehensive work and continuing integrated efforts are essential to create and adopt the proper national recycling programme concerning plastics as well as other discarded materials. This strategy must be a part of a nation-wide consciuos social practice of the enlightened citizens. This strategy shall encourage not only recycling of waste, but also use of other feasible recovery methods.

SCOPE OF THE PROJECT

The following goals shall be sought for:

A. MATERIALS FLOW OF PLASTICS IN JORDAN

Statistics survey on the different types of plastics materials, processes and applications in Jordan. Major types of economic relevance shall be identified. Detailed national statistics currently non existing shall be established and published for the first time in Jordan. A regional packaging conference held recently in Jordan revealed that such statistics are also not available within the Arab countries.

B. INCIDENCE OF PLSTICS WASTES

Investigation of the amounts, sources and places of occurrence of plastics wastes. Main waste streams shall be identified from the different household, industrial, commercial and agricultural sectors. Investigation of the capacity of the existing landfills and the availability of new sites for landfills. Investigation of the recyclable plastic waste sources.

C. COLLECTION AND CHARECTERIZATION OF WASTE STREAMS

Collection of plastics wastes from a selected model area(s). Other materials such as paper and metals shall also be investigated in this task in order to evaluate the actual impact of plastics wastes on the the total waste stream. This task shall reflect the practical feasibility of collection as well as the potential availability of economic amounts of plastics wastes and the consequent system and cost of collection. Initially, a primitive collection system shall be used and then based on the collected amounts, the feasible collection cost can be estimated . At the end of this task statistics on the composition of different waste streams shall be established and published for the first time. Such statistics shall be the guidelines for any future research or activity in the field of waste management. Based on the results of this task, strategies for solid waste disposal, source seperation and collection can be recommended. Also suggesstion of several environmental restrictions to be imposed on disposal and utilization of waste can be presented.

D. RECOVERY AND UTILIZATION OF PLASTIC WASTES

Classification and sorting of the collected plastic wastes. Suitable sorting processes must be introduced that yield high fraction of plastics waste thus allowing a feasible recycling process.
Investigation of other efficient recycling or recovery processes for plastics wastes that could be adopted by the local industry or the Municipilities . The study should present technological solutions to convert refuse into new material and energy resources and highlight the main problems to be overcome .
Investigation of the demand for recycled matrials on the markets as well as the market outlets for the application of recovered waste plastics. Preliminary economic feasibility has to be assessed.

E. DIFFUSION OF RESEARCH RESULTS

Diffusion and transfer of the results emanating from this research through a regional demonstration workshop .
Launching of educational environmental programmes through the media to enlighten the citizens about their role in the waste recovery programme and promote their environmental awareness.

The above tasks shall be carried out with the cooperation of the research, academic, governmental and environmental organizations in the country. Also , in achieving these goals , the experience of the advanced countries in the field of waste management shall be utilized through scientific visits and review of the relevant environmental strategies in these countries if made available. In this regard we seek the assistance of IDRC in guiding us to and facilitating the contacts with canadian environmental and district Municipalities
The project is expected to be completed over a three years period.

BENIFITS OF THE RESEARCH

• The whole population of the country shall benifit from a reduction in the environmental problems associated with the current improper and unregulated practices of waste disposal. One large open landfill in an urban area is causing serious odor problems to the neighbouring terotory with high population density . The immediate users of the results of the project are the small and medium size plastic convertors in the country who shall be keen to reduce their materials cost thus enhancing their economics of production. Lower price products shall also be available in the local market for the consumers. Energy may also be recovered from alternative methods of waste utilization such as incineration. On a national scale, the raw material imports shall also be significantly reduced thus relieving the strained national budget.

Additionally, hundreds of positions for non-qualified workers and technicians shall be created in the stages of collection, seperation, trasport besides the new recycling facilities that have to be adopted by the plastic convertors.

The proposed work shall have an impact on the region as a whole since this project is a pioneering work that has not been identified anywhere else in the Arab neighbouring countries. The potential results are expected to be a guide for regional waste management. A regional network may evolve for the coordination of waste management activities.

COLLABORATING INSTITUTES

The research shall be carried out and coordinated by the Royal Scientific Society(RSS), the leading R&D institute in the country. The Plastics Research Facility at RSS has been active in the field of platics waste recycling and utilization via state of the art technologies. A two-phase project supported gratefully by IDRC has recently been completed successfully with the cooperation of McGill University in Canada.

Jordan University (JU), Chemical Engineering department, shall participate in the investigation of seperation processes and waste recovery or recycling processes of plastics.

The Jordanian Environment Protection Society (JEPS), shall be involved in promoting the awareness of the citizens towards the waste management programme through educational social programmes. It shall also help in conducting the required surveys.

The Capital Municipality(CM) shall be involved in the collection of plastic wastes from the selected model area. It shall also contribute to the investigation of the existing landfills,

METHODOLOGY

Objective A

All plastic materials demanded by the local plastic convertors are imported. The total plastic materials imports shall be investigated(RSS) and classified. The national statistical bulletins classify plastic raw materials into inconsistent categories on different basis as shown below;

- Acetals, semiacetals and derivatives
- Polyester resins
- Liquids and pastes from polycondensation
- Blocks, lumps, granules, flakes and powders from condensation or polyaddition.
- PVC powder
- PVC granules
- Polymer granules other than PVC.

Such a classification cannot reflect the real imports and the significance of individual plastics used by the local convertors. Therefore, the survey shall utilize the various national facilities available such as the documents of the Ministry of Trade and Commerce , the national bulletins described above as well as the plastic convertors themselves.

A data base shall be established and manipulated (RSS) into tables of imported plastic materials classified according to the material , processing method and applications.

Objective B

Investigation of occurrence of waste streams(RSS) by observation and analysis of the whole distribution course of plastics : from raw materials, manufacturing via processing to consumption. Identification of main sources of waste incidence based on the accomplishments of objective A. Main sources are expected to arise from processing and manufacturing , from domestic waste, from agricultural waste and from the commercial use. The degree of mixing and contamination shall be taken into consideration.

Existing landfills shall also be surveyed . Their number, sites capacity and any other relevant information shall be explored(RSS;CM). The availability of new sites shall be addressed.

This task shall reflect the present situation of waste in the country.

Objective C

Collection of plastic wastes(RSS;CM). One or several model areas shall be selected. A preliminary experimental collection scheme shall be followed depending on the waste incidence. The composition of each tested waste stream shall be investigated and the recycling feasibility of those streams shall be evaluated(RSS).

The technical difficulties of this task should be noted due to the scattering of waste places , the heteroginity and the seperation difficulty.

Objective D

Different classification and sorting methods of the collected plastic waste shall be proposed and tested(JU). Other recycling or recovery processes that could be adopted locally shall also be surveyed. preliminary plant design for selected potential processes shall be laied out(RSS;JU). Also a priliminary cost analysis shall be carried out(RSS;JU).

Objective E

The results of this project as well as the recommendations for a future-oriented waste management shall be introduced (RSS;McG;JU) to the relevant governmental and private sectors in the country as well as to the surrounding countries in the region through a regional workshop held and organized by RSS. Additionally, educational programmes shall be launched through the media to raise the environmental awareness of the citizens (JEPS). In this regard it must be kept in mind that influencing the citizens behaviour is a long term process such that a dramatic improvement in the waste recovery from domestic waste streams is not expected during the course of the project.

PROJECT TIMETABLE

ACTIVITY	1ST YEAR				2ND YEAR				3RD YEAR			
	QUARTER NO.											
	1	2	3	4	1	2	3	4	1	2	3	4
Initial preparation, project set up and coordination.	↔											
Statistics survey		←	—	→								
Incidence of plastic wastes				←	—	→						
Collection and characterization of waste streams						←	—	→				
Evaluation & reporting							↔					
Recovery & utilization of plastics wastes		←	—	—	—	—	—	—	—	→		
Diffusion of results											↔	
Evaluation & reporting												↔

ATTACHEMENT N°: 3

Provisional Program of Workshop on Recycled PE Film Applications/Film (October 15-16) 1994

ATTACHEMENT N°: 3

First Day, October, 15, 1994.

9.00-10.00	Registration
10.00-10.45	Opening Ceremony

(Minister of Scientific Research and Technology, President of Academy of Scientific Research and Technology, President of National Research Center, President of Mansoura University, Dean of Faculty of Science, Mansoura University, Prof. Dr. Abbas A.Yehia, Prof.Dr. E.M. Abdel Bary, Prof Dr. M. Kamal) .

10:45 - 11:15	Break.
11:15 - 12:00	Demonstration of the main results of the project (Prof.Yehia)
12:00 - 12:45	Prof. M. Kamal -Canda "Plastics waste status and recycling options"
12:45 - 13:30	Eng. Nadia Khuraishi (RSS. Jordan).
13:30 - 14:15	Prof. Gamal Ghali.
14:15 - 15:30	Lunch.
15:30 - 16:15	Solid Waste Management in Egypt (Prof. S. Ragheb).
16:15 - 17:00	Prof. Teoman Tincer (Turkey) "Studies on PE Blends".
17:00 - 18:00	General Discussion.

Second Day, October, 16, 1994.

9:30 - 10:00	Prof. M.Bakar -Algiere "Algierian Experiment".
10:00- 10:30	Dr. Hosny Khalifa "Ministry of Agriculture"
10:30 - 11:00	Prof.Abdel-Bary "Developments in u.v. stabilizers.
11:00 - 11:30	Break
11:30 - 13:45	Visit to Green Houses Sites (Ministy of Agriculture)
13:45 - 14:45	Closing ceremony
14:45 - 16:00	Lunch

Subject: Evaluation of the final report of the project "Recycled Polyethylene Waste Film Application/ Egypt " and possibility of its extension to phase II.

A long and intensive discussion with Dr. Arul Iricibar during his visit to Egypt was conducted Besides, a visit and discussion with some public and private producers of green-house films and recycling plant was fulfilled according to his request. According to the fruitful discussions and the visits of different sites, the following conclusions can be derived:

1- The recycling of green-house film waste is a very hard job for all recycling plants in Egypt . This is due to the extensive deterioration of green-house films under the severe climatic conditions in Egypt and **no recycling plant** in Egypt is capable of or succeeded in obtaining pelletized recycled green-house waste. This is a positive point in the first phase of this project where it was possible to successfully recycle these wastes.

2- It is difficult to convince green house film producers to make use of our know-how **without carrying out field tests of these films** by green house division in Ministry of Agriculture under supervision of **Prof.Dr. Hosny Khalifa** who is one of the research team of the project. A comparison of the durability of these films and conventional produced films **should allow to recommend the production** of our developed three-layer film according to the advice of Ministry of Agriculture. **Only in this case**, the developed films and the new technology can be distributed.

3- It is our belief that the organization of the Workshop should help to demonstrate our technology for guests from other countries such as Algeria which has about 38% of the total amount of greenhouse films in Arabic World. The workshop will also assist in experience exchange and will enrich the second phase of the project.

Accordingly, we strongly ask the IDRC authority to extend the project in order to fulfill the second phase according to the provided proposal.

Prof. Abdel-Bary and Prof. Yehia

SUMMARY OF SHALE BRICK

PRODUCTION (EGYPT) RESEARCH

PROJECT

The majority of problems that developed in small as well as large scales of production activities in shale/clay brick plants may be related directly to the inherent properties of the locally available shale/clay deposits. The deleterious properties of this raw materials can be summerized as follows:

- High content of montmorillonite which requires a high amount of water to produce a workable paste "high plasticity" and cause high percentage of shrinkage on drying and high drying sensitivity.

- The relatively high content of sodium chloride in shale/clay deposits (2-4 %). The adverse effect of Nacl are presented in high corrosion of metallic parts, Pollution of surrounding environment and partial contribution to the development of efflourescene in the final product.

Therefore, this research project aims at:

- Investigate possible methods and means of decreasing plasticity, drying sensitivity and drying time of Egyptian shale/clay.

- Investigate possible methods and means of counteracting the high sodium chloride content of the Egyptian shale/clay.

- Decreasing feul consumbstion during the firing process.

- Up-grad the quality of final product.

After an extensive survey by the General Organization for Housing Building and Planning Research, Cairo-Egypt, shale/clay from seven representative deposits were selected from the project. The locations from which they were selected were Belbeis, Kafr-Homeid, Kom-Osheim, Geneifa, El-Saff (1), El-Saff (2) and El-Khatatba.

The characterization investigations included, chemical composition, mineralogical analysis, differential thermal and thermogravimetric analysis, paricle size analysis, surface area determination, plasticity coefficient, shrinkage during drying and dimensional measurements during firing by thermo-mechanical analysis.

Results show that plasticity coefficient was high for all the clays, ranging between 31.5 and 40. The drying sensitivity coefficient was ranging between 1.23 to 2.17. In addition, results show that all clays containing soluble chlorides and sulphates in the range 0.31-2.57 % and 0.38-1.66 %, respectively. They are present as salts of sodium and potassium. They enhance the plasticity of the clay, lower the vitrification temperature of the clay during firing and cause evolution of chlorine gas during firing. There are also problems associated with the use of the sand including the development of low strength in bricks and abrasion of the equipment. In order to solve these problems, a three yeer project was developed by NRC, Canada, GOHBPR, Egypt and IDRC, Canada. To achieve the objectives of the present research project, the effect of different treatment and addition of some additives to three clays viz, Belbeis, Kom-Osheim and Kafr-Homeid were chosen for this study were investigated. These additives were:-

- Effect of addition of chemical compounds:-

The effect of addition of alkaline and acidic compounds on the lasticity was studied. The results show that the clay becomes more tiff by the addition of alkaline compounds, such as sodium exametaphosphate, sodium hydroxide, and black liquor (sodium gnosulphonate). This reflects that the plasticity coefficient was creased, i.e. a negative influence. The addition of acidic mpounds (acids) such as acitic, tartaric and cetric acids results a general decrease in plasticity within the range of ncentration studied. Citric acid had the least effect; both taric and acetic acids produced positive influence, i.e. they reased the plasticity coeficient value by 7% to 9% by the ition of 0.75%. In addition, a significant decrease in the drying sensitivity coefficient (D.S.C.) was also took place. The compressive srtength of the produced bricks was recorded an increase specially for specimens fired at 900°C. However the drawback for using the acetic acid is the increase in the cost production of bricks by about 25-35 % whereas price of one ton commercial acid is 2000 E.pound.

II- Effect of calcination of the raw clay:-

Results showed that calcination at temperatures up to 300°C resulted in a relative increase in P.C., whereas clays calcined at 400°C had almost the same P.C. as the dried clay powder. Significant decrease in P.C. took place at temperature higher than 400°C and the clay become non-plastic by calcination at 600°C. Results also showed that, Na^+ and Cl^- in a water soluble form, decreased with increasing the calcination temperature. Calcination at 400°C results in approximately 30% to 40% decrease in these two elements. Increasing the calcination temperature to 500°C in a decrease of approximately 50% of Cl^-. Calcination of the clay at approximately 350°C shows that a significant decrease in the drying sensitivity coefficient (D.S.C.). Calcination of the clay at 200°C, 300°C and 400°C followed by reforming bricks, resulted a significant development in the strength, specially for those calcined at 300°C which had the highest relative compressive strength.

III- Effect of addition of different amounts of siliceous sands:-

The addition of siliceous desert sand to the clay, which is the currently followed technique in the brick industry, resulted in significant decrease in the plasticity. Thus the plasticity coefficient is decreased through the addition of sand up to 50% by weight. In addition, a significant decrease in the drying sensitivity coefficient (D.S.C.) took place as a result of the addition of 15% to 50% (by weight) sand. However, the drawback of this method is the decrease in the mechanical properties of the product and abrasion of the equipment. The increase of sand content of the mixture up to 50% results in a decrease of the strength by 40-60% with respect to samples with 15% sand.

IV- Effect of addition of different amounts of grog:-

The addition of grog resulted in a significant decrease in a plasticity with increased additions. Thus the value of plasticity coefficient decreased by about 34% by increasing the grog content to approximately 50% by weight. The drying sensitivity coefficient of mixes contain grog showed also a significanc decrease in the values. In addition, the chlorine content of grog material is almost negligible and the Na^+ present would be in a combined form. Accordingly, the overall content of Cl^- and Na^+ in the form of NaCl would decrease with the increase of the grog in the mix. The addition of grog resulted in increase compressive strength by 150-250 % relative to corresponding mixtures with sand fired at the same temperatures. Samples with 15% grog and fired at 850°C show the highest compressive strength values in this group. The strength decreased by about 40% by increasing the grog content to 50% and firing at 850°C. The results show also that increasing the firing temperatures of these mixtures from 850°C to 900°C resulted in no significant development of compressive strength.

V- Effect of addition ~~of different amount~~ of different amounts of limestone powder:

Limestone powder can generally be decreased as non-plastic; However, a certain degree of plasticity could develop in extremely fine grained powders. This part in the work has demonstrated the possibilty of complete or partial replacement of quartz sand with limestone powder. This would open and widen the scope of utilization of limestone, resulting in larger opportunities to vary the mix design in a manner that would achieve optimum production conditions.

Generally, the results show that the addition of 15% by weight limestone powder could decrease the plasticity by 3%-4.5%. In comparison, a similar amount of siliceous sand (15% by weight) would decrease the plasticity by about 6%.

The addition of limestone positively modifies the drying behaviour and drying sensitivity. Accordingly, the addition of 15% limestone modifies the DSC to a level that can only be obtained from the addition of relatively higher amounts of quartz sand.

The benefits of mixing limestone powder with Egyptian shale/clays up to 15% by weight were particularly impressive in firing stage of production and the quality of fired products. The results showed that energy saving between 23% and 17% could be achieved by producing the firing temperature to 700°C and 750°C respectively.

The compressive strength of fired products with limestone increases by about 10%-15% of that recorded for corresponding mixtures with sand. In spite of the above mentioned positive achievements that resulted by the addition of limestone powder, the following factors have to be taken into account:

The unit cost of acquiring or obtaining the limestone powder may be comparable to that of sand at present, however, as the demand for this by-product increases, the price fluctuate.

- Additional preparation stage of the limestone powder may be required in the future to ensure the quality, particularly the degree of fineness.

For these reasons an overall increase in the cost of raw materials may be expected and may reach 20% to 25% of current rates.

Received ... 1994 ...

ATTACHEMENT N°: 6

GENERAL ORGANIZATION

FOR HOUSING.BUILDING & PLANNING RESEARCH

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DOKKY, CAIRO, A.R.E.

Prof. M.Ramez
Chairman,
GOHBPR, P.O.Box 1770,
Dokki, Cairo,
Egypt.

Dr. Fawzi Kishk
Director,
IDRC-Middle East and North Africa
Regional Office,
Cairo,
Egypt.

RE: Shale Brick Production/Egypt

Dear Dr. Kishk,

As you know, last December, Dr. John Jaffray from IDRC/Canada visited us in GOHBPR after he arrived to Cairo from Palastine. We had a long interesting conversation about the history of the project and its results.

Dr. Jaffray appreciated the quality of the research done and the importance of the results obtained. His discussion concentrated on the possible applications of the project's results in Egypt and its neighbouring Arabian and African countries.

Based on this meeting, we take the liberty of submitting a proposal for a semi-industrial scale experimentation required for the possible practical implementation of the results of this project. We hope that IDRC will appreciate the importance of the proposed phase.

Enclosed please find the proposal for such a supplementary research program. We appreciate submitting it to IDRC/Canada accompanied by your support.

Please accept my best regards.

Yours Sincerely

M. Ramez

Prof. M.Ramez

30.1.1994

Shale Brick Production/Egypt

A Proposal for a Supplementary Research Program Submitted to (IDRC/ Canada)

Background:

On March 20, 1989, IDRC/Canada approved a grant to GOHBPR/Egypt to enable it to carry out - in collaboration with NRC/Canada- a research project concerning "Shale Brick Production in Egypt". The project started Sept 1, 1989 and extended till May, 31, 1993.

The project investigated the challenges confronting the brick production industry in Egypt through three phases, these were:

<u>Phase I:</u> (Sept. 1989 - Sept. 1990)

This phase included:
- Sample selection and characterization.
- Preliminary studies on the effect of non-plastic additives on the technological properties of shale/clay.

<u>Phase II:</u> (Sept. 1990 - Sept. 1991)

This phase investigated:
- Modification of the plasticity of Egyptian shale/clay.
- Improvement of the drying behavior of molded articles.
- Decreasing the available chlorides in the clays and the fired product.
- Investigating the quality of the fired product through chemical, physical and mechanical testing.

<u>Phase III:</u> (Sept. 1991 - May 1993)

This last phase included:
- Semi-Pilot scale implementation of results.
- Recommendations.

The judgement of the refrees who were nominated by IDRC to review the project reports was that the research done and the results obtained were very impressive and could have a great impact on the construction industry and housing sectors in Egypt.

These successful results that were obtained through the joint collaboration between GOHBPR/Egypt and NRC Canada were the major incentive for placing the current supplementary rescarch proposal.

Objectives:

The main objectives of this proposal are:

a) Technical benefits:

Adopting the project results on a semi-industrial scale, thus, contributing to solve some of the acute problems that are confronting the shale brick industry in Egypt. Moreover, an outlook is to achieve deployment of the developed technology not only between beneficiaries in Egypt, but also, among Arab and African countries that suffer from the same problems and are looking for a relevant technology to adopt.

b) Economic benefits:

Represented by the savings obtained by:

- Reduction of the percentage of waste from the different production stages.
- Overcoming the corrosion of equipment that ensue due to aggressive salts.
- Reduction of current severe abrasion of equipment caused by excessive amounts of sand used.
- An overwhelming benefit is the production of good bricks at a relatively low cost that will have an impact on the overall cost of construction as well as the durability of buildings.

c) Social benefits:

Represented by the preservation of the level of the current employment in the brick industry since employment is an urgent social requirement in Egypt nowadays.

Research team

The research team will be essentially researchers, associates and assistants from the department of "Raw Materials and Processing", GOHBPR, Egypt (in collaboration with researchers from the "Materials Section", NRC, Canada).

Technical Program:

1- Characterization studies of the limestone deposits exploited in quarries around Cairo and could serve their neighbourig brick plants.

2- Fabrication or up-grading of already present pilot-scale equipment for brick production at GOHBPR .

3- Establishing the proper mixes to be utilized on pilot-scale.

4- Brick processing-using ready optimum mixtures in a traditional brick plant up to the drying stage.

5- Firing the dried bricks under differrnt controlled firing cycles, thus, establishing the optimum firing conditions.

This program will serve establishing the feasibility of the proposed technologies.

Program Duration

12 months starting April 1994.

Budget

Budget items (in Egyptian Currency) including both GOHBPR and IDRC contributions will be approximately as indicated in the attached form. In order to secure fulfilment of the needed research requirements, the required fund should be forwarded to GOHBPR by the beginning of the program execution.

Technical Report and Financial Statement

Upon completion of the program, GOHBPR will forward to IDRC a technical report and a financial statement on this supplementary program.

Visits to Project

The budget will permit a trip to Canada before the end of the program to facilitate discussion of the results and the conclusions achieved.

Principal Investigator

Prof. M Ramez,

Chairman GOHBPR.

Budget
(in Egyptian Pounds)

egories	IDRC Contribution	GOHBPR Contribution
aries and Allowances:		
earchers	44,280	44,280
earch Assistants	28,800	28,800
hnicians	10,100	10,100
	83,180	83,180
earch Expenses		
eral Utilities	27,000	--
Facilities and ot Plant Activities	5,000	20,000
kshop Facilities	2,000	10,000
	34,000	30,000
port Services		
retarial and Administrative k and Report Preparation	6,000	6,000
p : Cairo/Ottawa/Cairo* 10 days. vice-versa awa/Cairo/Ottawa.	12,150	--
Total	135,330	119,180

'his part should be administered by IDRC.

e: Except the probable trip to Cairo, the above-mentioned budget does not include any fund that might be needed for activities by NRC/Canada.

Lamey

. . . .

Shale Brick Production (Egypt)
Project: 88-1045 ISN: 13511

Donor : IDRC
Funding Unit: EES - Building Industry, Materials and Technologies

The population of Egypt has increased from 16 to 50.4 million during the last 50 years. This phenomenon has resulted in a gradually increasing shortage of low-cost housing which is now acute. Brick is one of the basic materials for this housing. Traditionally, raw materials for brick have been the agricultural soils themselves. At present, to protect agricultural production, the small-scale brick plants are not permitted to use the top soil of agricultural land and Nile silt. Other available resources aré shale which has a salt content, and adverse swelling and shrinking characteristics. The few brick plants using shales are producing poor quality bricks because they use traditionally known technology which is unsuitable for shale. More than half of these plants have stopped production because of this problem. This project will support the development of a suitable technology for the existing small-scale brick plants using shale as a raw material. Researchers will carry out characterization studies of shale; and establish the process and production parameters adaptable to the existing brick plants for the production of low-cost burnt bricks using shale.

Macrothesaurus Descriptors: /bricks/ /low cost housing/ /small-scale industry/ /industrial engineering/ /industrial processes/ /appropriate technology/

Other descriptors : /shelter/

Area under study : /Egypt/

Amount of grant : 387700 CAD
Fiscal year : 8889
Date funds committed : 19890831
Completion date : 19920831
Status : Closed

Recipient: National Research Council of Canada, Ottawa, ON, CA
Address: National Research Council of Canada, Montreal Road, Ottawa, Ontario, Canada K1A 0R6
Recipient contribution: 61800
Donor funds: 173610
Researcher : see researcher A below

Recipient: General Organization for Housing, Building and Planning Research, Cairo, EG
Address: General Organization for Housing, Building and Planning Research, P.O. Box 1770, Tahrir St.,

Dokki, Cairo, Egypt
Recipient contribution: 102300
Donor funds: 214090
Researcher : see researcher B below

Researcher A : Ramachandran, V.S. Dr

Researcher B : Ramez, M.R.H. Dr

PROJECT-RELATED DOCUMENT(S) IN IDRC LIBRARY:

Shale Brick Production (Egypt), phase III, Sept. 1, 1991-May 30, 1993 : progress report. 1993. 114 p. : ill.
Location: ARCHIV 691.31(621) R 3
BIBLIO ISN: 96908

Shale brick production (Egypt) : evaluation report, Oct. 1992. 1992. 15 p. in various pagings : ill.
Location: ARCHIV 691.31(621) G 5
BIBLIO ISN: 99942

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Recycled Polyethylene Waste Film Application (Egypt)
Project: 90-1005 ISN: 14272

Donor : IDRC
Funding Unit: EES - Technology for Local Enterprises -- Industrial Chemicals

The use of plastic films for greenhouse applications has increased drastically in the Middle East in the last 15 years. Import in the form of films and pellets necessary for their local production has constituted a strain on the foreign currency reserves in the countries in the region. A technology to recycle waste polyethylene films into new agricultural film was developed for the Jordanian materials and conditions. This project will transfer and adapt the technology developed in Jordan to suit raw materials, weathering conditions, and existing manufacturing techniques in Egypt. It will also extend the technology to enable the use of polyvinyl chloride into the films. The results of this collaborative project will be of benefit to the farming community by decreasing the cost of plastic films used in the construction of plastic greenhouses. The know-how developed will be shared with plastic converters in Egypt and surrounding countries through national seminars and a demonstration workshop in Cairo.

Macrothesaurus Descriptors: /plastics/ /waste recycling/ /greenhouses/ /technology transfer/ /import substitution/ /renewable resources/ /resources utilization/

Area under study : /Egypt/

Amount of grant : 231700 CAD
Fiscal year : 9091
Date funds committed : 19911118
Completion date : 19931118
Status : Active

Recipient: McGill University. Department of Mechanical Engineering, Montral, Qubec, CA
Address: McGill University, McGill International, 3550 University Street, Montral, Qubec, Canada H3A 2A7
Recipient contribution: 76500
Donor funds: 45300
Researcher : see researcher A below

Recipient: National Research Centre, Cairo, EG
Address: National Research Centre, Tahrir Street, Dokki, Cairo, Egypt
Recipient contribution: 99700
Donor funds: 145700

Researcher : see researcher B below

Recipient: Royal Scientific Society, Amman, JO
Address: Royal Scientific Society, P.O. Box 925819, Amman, Jordan

Recipient contribution: 27000
Donor funds: 40700
Researcher : see researcher C below

Researcher A : Kamal, M. Dr

Researcher B : Yehia, A. Prof

Researcher C : Khadra, H. Dr

PROJECT-RELATED DOCUMENT(S) IN IDRC LIBRARY:

Recycled polyethylene waste film application, Egypt. 1994. 26 p. : ill. (Final report)
Location: ARCHIV 678.5:631(621) K 4
BIBLIO ISN: 100889