ALTERNATIVE FOOD PROCESSING EQUIPMENT STUDY FOR THE ICDS PROJECT

GODHRA, GUJARAT STATE, INDIA

JANUARY, 1989

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SUMMARY

Objective

Officials with USAID and GOI concluded that little hope existed in resolving how to handle an importation tax assessed to extrusion equipment which they wish to import into India for the Integrated Child Development Services (ICDS) project USAID was unable to pay the tax because of internal regulations and the Government of India did not have sufficient funds to pay the tax Because of an importance to maintain project momentum, they desired to know what alternative(s) might be available to replace the previously recommended Insta-Pro extruders and still achieve the goal to produce a supplementary weaning food in Godhra A request was made for technical assistance to assist in solving the current problems with an objective of providing the USAID and the GOI with a series of processing alternatives that could replace the Insta Pro extruders specified for the Panchamahals District supplementary food processing plant These alternatives would provide a basis for the selection of a new process and provide a planning document for the project

Procedures

Reports and documents supplied by USAID were read during the assistance period to gain an understanding of the project and insight into the extent to which the existing problem had been addressed Briefings at the USAID office and Ministry of Human Resource Development (MOHRD) were held to further define the problem from an administrative level Site visits to Godhra, Baroda, Ahmedabad and Bhopol were made to visit the plant site manufacturers of extruder equipment state government officials and an operating extrusion processing plant respectively Information was

collected during these visits to develop and support the conclusions and recommendations of the study

Processing Alternatives Considered

Primary emphasis of the study was placed on finding extrusion processing technology within India to maintain an objective for the Godhra plant of producing weaning foods, snacks and finger foods Since the Godhra plant building had been completed with the exception of the processing area and because most of the equipment had been ordered substitute processes for the extruders had to fit within the existing process design and building Other factors used to evaluate alternatives included capital cost time required to implement an alternative, operating cost capabilities and limitations to make products, and complexity of operation

Alternatives considered suitable for use in the Godhra plant and which met the evaluation criteria included

1 Insta-Pro Extruders - The original equipment selected for the plant was included in the alternatives analyzed as a basis for comparison and because some possibilities existed to resolve the importation tax issues and proceed with the original project plan

2 Indigenously Made Extruders - A manufacturer of extrusion equipment and ancillary equipment to support the extruder was located in India The company had background in fabrication of extruder parts and decided to build their own version of a Wenger type extruder Two models having a capacity of either 250 or 800 kg/hr were available from the company An extruder with the lower capacity was being used to make TVP in India Reports from the users indicated that the extruder was making satisfactory product, but experiencing some mechanical problems

The two differently sized extruders gave flexibility in selecting options to replace the Insta-Pro extruders and meet production rquirements for the Godhra plant One option would be the selection

of one large capacity extruder and the second would be to install from one to four of the smaller extruders Advantages of using this equipment included local availability of parts and technical backup processing flexibility in formulations and high quality products A primary disadvantage for these options was the additional capital required to implement them in the plant

3 Roasting/Grinding/Mixing - This technology was developed in India and currently used in several plants throughout the country including a plant in Chandrapur which is part of the ICDS project The large base of experience with this technology coupled with the cost to implement it made it a viable alternative to consider in the study The primary disadvantage for this alternative was the inability to manufacture textured and shaped snack or finger foods

4 Brady Extruders - The Brady extruder has been used extensively to manufacture weaning foods in other countries plus it is currently used in India to heat stabilize rice bran Advantages for considering the Brady as an alternative included the capital cost ease with which it could be installed in the plant process line and a potential for the unit to be made in India in the future Primary disadvantage for the unit was the inability to make anything other than a ground weaning food and some concern about recent changes to its design and the effect on operation using cereal based formulations

Conclusions

It was concluded that a method to pay the taxes for importing the extruders has delayed the implementation of the Godhra plant USAID is unable to pay the duty and the GOI has no funds available and will not waive the import tax for the project Therefore, it was necessary to explore other processing alternatives to enable the project to continue There was no clear understanding of what the tariff for an extruder should be since rates were reported different depending on the source

Both imported and indigenous extrusion equipment was found suitable to use in manufacturing weaning food, snacks, and finger foods Imported extruders such as the Insta-Pro have the advantage of minimizing the amount of modification required to the plant design They reduce the uncertainty of producing a satisfactory product continuously, are the choice of process by project personnel staff and officials in the project and they are low cost Their main disadvantage is the requirement of importation taxes Technical back-up and replacement parts are not readily accessible without importation

Indigenously made extruders require some modification to the existing plant layout in order to incorporate them into the plant High quality products can be made with these extruders at high moisture contents necessitating some drying of the products Costs for the local extruders are high due to the need for ancillary equipment such as steam generators, dryers, additional conveyors, and upgrades for other equipment to support the extruders Advantages include the ability to make all types of foods specified for the plant Since the extruders are made in India access to parts and technical backstopping are available

Roasting/grinding/mixing was also a technology that could be used in the Godhra plant To implement the technology only roasting and heating equipment would have to be added All other ancillary equipment such as mixers etc is available to support the roaster Advantages of using the roasting process include lower capital cost, it is made in India and a large amount of experience exist to support the technology The main disadvantage of this process is a limitation in flexibility of products other than a cooked relatively insoluble flour which hydrates only with some boiling in water

The analysis of alternatives indicated that the most attractive alternative would be the roasting process This alternative minimizes capital cost and maximizes the use of indigenous technology The premium paid for using this technology is the inability to make snack and finger

foods and the processing of a weaning food with limited functional properties The second most attractive alternative requires purchase of the Insta-Pro extruders The premium paid for this option is the cost of duty (Rs 938,000) Since USAID will buy the equipment consideration might be given to waiving the duty in which case no premium is paid for this option

The premium paid in using an indigenously made extruder which enables reaching production goals was found to be an additional Rs 2 200 000 when compared to the Insta-Pro extruders and the uncertainty associated with selecting equipment that has little track record

Recommendations

It was recommended that the project continue to work towards an operational plant in Godhra and to resolve the current importation problem The need exists in the Panchmahals district for a production facility to support the food component of the ICDS project Abandoning the investment in the plant of up to Rs 3,000,000 would not be practical Abandoning the project would also strain relations between groups participating in the project

It was recommended that the duty be paid or a method found to waive the duty for the purchase of the Insta Pro extruders The uncertainty on what the actual assessment might be complicated resolution of the issue Eliminating the tax requirements from the project would result in the least cost for the Government of India, State Government of Gujarat, and USAID It would permit the purchase of the Insta Pro extruders giving the quickest and most satisfactory method of achieving project goals for the plant

In the absence of a resolution on the importation tax issue it was recommended that the least cost indigenous technology which is roasting

be installed in the plant It was also recommended that consideration be given to the indigenous extrusion technology equipment if and only if the project is unable to implement either of the Insta-Pro or roasting technology alternatives

It was recommended that a formulation for the weaning food be established to enable a rapid start up of the plant once equipment were in place There had not been any firm decision on the formulation that would be used in the plant The lack of a formulation complicated the evaluation in selecting a suitable alternative process Identification of a formulation in the near future would permit some preliminary testing prior to start-up of the plant regardless of the process selected It was also recommended that a study be carried out to determine how an optional roasted weaning food could be made This recommendation was also made in the Harper Jansen report and repeated in this report to reinforce the importance of these tests Changes to operating parameters or the formulation may have to be made to achieve satisfactory results

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JANUARY, 1989

BY Ronald E Tribelhorn(1)

1 0 BACKGROUND

In 1975, the Government of India (GOI) launched a pilot program to meet the health, nutrition, social, and educational needs of pre-school children (1) The goals for this program were

1 Improving the nutritional and health status of children 0-6 years of age
2 Laying foundations for proper psychological, physical, and social development of children
3 Reducing incidence of mortality, morbidity, malnutrition, and school drop-outs
4 Improving unity among various government departments to promote child development
5 Enhancing capabilities of mothers to look after normal health and nutritional needs of children

Through efforts by the GOI and State Governments, this program, known as the Integrated Child Development Services (ICDS) has increased its

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beneficiary levels during the past 13 years and now serves approximately 1 952 blocks of population with each block containing 100,000 people The project was designed with elements of supplementary feeding, pre school education, immunization, health check-ups, referral services nutrition and health education and non-formal education of women

The United States Agency for International Development (USAID) in an effort to assist the ICDS project granted funds of $10,000 000 and guaranteed loans up to $7,000,000 to develop a comprehensive approach to alleviate child malnutrition through supplementary feeding programs nutrition education, and health services Funds were specifically earmarked for technical assistance, training research food processing plants, project monitoring and evaluation Some funds were also committed to use for furniture, equipment, staff and operating expenses

Two districts served by the ICDS project, Chandrapur in Maharashtra State and Panchmahals in Gujarat State were selected as locations to implement the USAID funded project By limiting the population served by the project to the above locations provided food and services could be properly supplied

USAID assistance to the ICDS project allocated funds to set up Ready-to-eat (RTE) food processing plants in each of the beneficiary districts To assist in the selection of an appropriate technology for these plants Drs Judson Harper and G Richard Jansen from Colorado State University provided technical assistance in July/August 1985 The result of their efforts was a feasibility study (2) which recommended specific processing technologies for each plant location The selection was based on a review of available technologies in India and on the specific food requirements in each district

The study showed that both roasting/grinding/mixing and extrusion were appropriate technologies for use in the ICDS project scheme Advantages and disadvantages of each technology were described in the report and no

clear advantage was seen for one system over the other Both were low cost from an initial investment standpoint and processing costs were found to be similar Interest in both technologies was evidenced by different groups involved with the project therefore a recommendation was made to install both systems in India It was recommended that a roasting/grinding/mixing process would be utilized in Chandrapur Maharastra State and that extrusion would be appropriate for a plant in Godhra Cujarat State

2 0 BACKGROUND FOR SELECTION OF INSTA-PRO EXTRUDER

The problems addressed in this study center around the extrusion process selected for the Godhra site Background information on extrusion and the circumstances that led to the selection of this technology is given at this time for review Harper and Jansen described the advantages of extrusion as

1 Capable of producing a pre-cooked cereal type product that makes smooth "instant" gruels suitable for feeding infants
2 Requiring minimal handling of materials from raw ingredients through packaging, thus producing a hygienic product
3 Capable of producing RTE snacks and finger foods with a variety of shapes, sizes tastes and textures

Disadvantages also described included

1 Extruders required importation in the absence of indigenous sources for this type of equipment
2 Susceptibility to plugs during time of power failures necessitating down times to clean machines

The Kaira District Cooperative Milk Producers Union, Ltd had proposed a Low-cost Extrusion Cooker (LEC) based process to produce RTE foods at

the Godhra site The proposal was a result of this group's previous involvement with LEC machinery and specifically the Insta-Pro extruders Because of the experience with LEC and Insta-Pro extruders along with certain capabilities of the Insta-Pro to make shaped finger foods a recommendation was made to use this technology in Godhra

3 0 CURRENT PROJECT STATUS

In 1987 the roasting/grinding/mixing plant began operation mostly producing Sukhada, a sweetened cereal legume blend The plant has been operating successfully since this time with only minor problems due to equipment breakdown The site was not visited

Progress towards the establishment of an extrusion processing plant in Godhra has not been successful Procedural problems in procuring the specified Insta-Pro extruders have arisen due to a need to be imported from the United States GOI regulations for importation of foreign equipment specify that an importation tax of 140% be assessed Responsibility for the payment of this importation tax has not been resolved USAID has money available to purchase the equipment, however, is unable to expend money for importation duty or other taxes due to agency regulations Since USAID cannot pay the tax the burden falls upon the State Government of Gujarat and/or the GOI, neither group having sufficient funds to make the tax payment A substantial amount of time has passed during which efforts have been continuously made to find ways of paying the tax or gaining a waiver of taxes To date, no resolution of the problem has been achieved

Requests to resolve the problem have also been made by the Panchmahals District Cooperative Milk Producers Union, Ltd This group has agreed to erect a building to house the extrusion plant, operate the plant and serve as the administrators for the selection and purchase of local equipment To date the building has been financed and erected and the

majority of equipment ordered An investment of Rs 30 lakhs (Rs 15=$1) has been reported as expended for the building plus Rs 10-12 lakhs for equipment, the latter being reimbursable from USAID

The large investment and erection of the building represents a firm commitment to the project by the Panchmahals Milk Producers Union They feel that unnecessary expense is being incurred by their company due to investment costs and non-use of the building The result has been a waning interest in the project

Officials with USAID and GOI do not see any immediate solution to the current extruder purchase and importation tax problems and conclude that little hope exists for the importation tax to be either waived or funded by the Government Because it is important to maintain the current relationship with the dairy group and the momentum of the project, they now desire to know what alternative(s) might be available to replace the Insta Pro and still achieve the goal to produce a supplementary weaning food in Godhra A request was made for technical assistance to evaluate various alternatives The following summarizes activities of this assistance

4 0 STUDY OBJECTIVES

The objective of this study is to provide the USAID and the GOI with a series of processing alternatives for the Panchamahals District Supplementary food processing plant that might be used in place of the Insta-Pro extruders These alternatives would provide a basis for the selection of the process and provide a planning document for the project

To meet these objectives, several tasks were assigned by USAID

1 Study supporting reports of the project to become familiar with the project and rationale for the plant design and potential solutions for the Godhra plant

2 Discuss with USAID and GOI officials the problems associated with plant construction and completion

3 Review the availability and suitability of indigenous technology for producing local weaning foods to determine the best alternative(s) for the plant

4 Visit the plant site at Godhra, to survey the status of the plant and equipment installation and discuss with officials potential changes to the plant

5 0 APPROACH TO WORK ASSIGNMENT

The study was completed in several phases (1) report review, (2) site visits, and (3) analysis and report writing

5 1 Report Review

Reports and documents supplied by USAID were read during the assistance period These included the USAID Project Paper (1), the report by Drs Harper and Jansen (2) and several files of correspondence and reports during the last few years which addressed the existing problem This information was useful in understanding the project and gaining insight into the extent to which the existing problem was addressed

5 2 Site Visits

The study period began with a briefing at the USAID office conducted by Mr Samaresh Sengupta Also attending were Mr Spencer Silberstein and Mr Y P Kumar Following this briefing a meeting was held with Mr Ashok Sinha, Deputy Secretary of the Ministry of Human Resource Development (MOHRD), GOI Also present were Mr Suman Nayar and Mr K L Gupta, both Under Secretaries, MOHRD

Site visits to Godhra Baroda Ahmedabad and Bhopol were made to visit the plant site, manufacturers of extruder equipment, state government officials and extrusion processing plant respectively Information was collected during these visits to develop and support the findings presented in this report

5 3 Analysis and Report Writing

The report was completed in New Delhi All data collected were analyzed and appropriate conclusions and recommendations were made

6 0 GODHRA SITE VISIT

A trip was made to Godhra to review the status of project activities there and to discuss with Panchmahals District Cooperative Milk Producers Union personnel, reasons for the evaluation addressed in this document its objecti es and potential solutions for solving the extruder importation problem

Personnel from the Milk Producers Union expressed concern about any building modifications which may be required to accommodate changes necessitated by installation of alternative processing equipment to the Insta-Pro extruders The criteria that was being used to determine if an alternative is suitable were explained enabling personnel to see that any selection would not require building structure modification Only repositioning of equipment would be required to accommodate any alternative Any concerns about this and other issues were resolved by the end of the visit

The building was inspected during the visit The following summarizes my observations of the facility

1 The building was approximately 90% complete The floor in the processing area was left to complete

2 Overall, construction and the finished surface appeared to be suitable for a food processing plant

3 There appeared to be no window screens on the building openings, however, these can be installed later

4 Some of the storage area was being used to warehouse materials for other processes at the site

5 Only a small amount of equipment was available at the site Major pieces of equipment were not available for inspection

In summary, the Milk Producers Union has done a good job to date of ensuring the a suitable enclosure for the food factory is in place

7 0 ALTERNATIVES CONSIDERED

Drs Harper and Jansen studied and reported on a number of technologies considered suitable for processing RTE foods in the ICDS project Their analysis narrowed the selection, leading to a recommendation to use both technologies as a means of making RTE foods and enabling an evaluation of the most appropriate processing technology to proliferate in India

In keeping with the Harper and Jansen recommendation of placing an extrusion process in Godhra, primary emphasis was placed on finding this type of processing technology within India as a solution to the current problem It was assumed that extrusion would be the only suitable processing equipment that would enable the manufacture of a weaning food, snacks, and finger foods and thus, meet objectives for the Godhra plant Only as a fall back situation would other processing techniques be considered

Since the building has been completed with the exception of the processing area and because most of the equipment has been ordered any substitute process for the extruders must fit within the existing process

design and building Processes that would require excessive modification to the equipment layout or to the building were considered inappropriate

Other factors such as capital cost, time required to implement, operating cost capabilities and limitations to make products, and complexity of operation were also used to evaluate alternatives

7 1 Alternative A - Insta-Pro Extruders

7 1 1 Descriptive Information

The Insta-Pro extruder is a dry type extruder operating optimally in the moisture range of 12-18% (wb) The extruder accepts dry granular materials and without the addition of steam or heating jackets is able to produce expanded, cooked, and shaped pieces Generally, no drying is required subsequent to extrusion, however air cooling is necessary to condition the extruded product for grinding when making a weaning food Under certain conditions, some drying may be necessary to make snacks or finger foods

7 1 2 Rationale for Selection

Reasons for selection of the Insta-Pro as an alternative have been presented by Harper and Jansen Rationale for including the Insta-Pro in this study include

1 Previous studies have determined that this extruder represents the optimum equipment selection to satisfy processing requirements in the Godhra plant

2 No modification to the original plant design or equipment flow would be required

3 The cost for the Insta-Pro alternative gives a basis to compare other alternatives

4 Officials and project personnel still feel the Insta-Pro extruder is the optimum solution to their process needs

7 1 3 Implementation of Alternative

The purchase of Insta-Pro extruders represents the least amount of modification work and the shortest time period between now and plant start-up of any alternative Since the design was based on the Insta-Pro extruder, no modification to the process design would be required to implement the alternative

7 1 4 Economics of Alternative

The last information indicating the cost for two Insta-Pro Model 2000 extruders was a quotation dated July 29, 1986 At that time, the cost for each extruder without duty and inclusive of cost, insurance and freight (CIF), Bombay was U S $54,200 or a total of U S $108,400 Adding a 15% increase for inflation would make the current estimated cost for the two machines approximately U S $125,000 (Rs 18 75 lakhs)

USAID has funds to cover the cost of purchasing the two machines As mentioned earlier, an estimated duty of 140% was anticipated for this equipment It should be noted that during the consultancy visit, the Fifth International Food Exposition - AHARA/ INDIA PACK 1989 was visited One of the exhibitors, showing imported extrusion equipment, indicated that a variation of the importation tax existed that specified a special tariff rate for certain imported food processing equipment of 35% Extruders of cereal products fall with in this category and therefore, if this variation is valid, the anticipated cost for importation of the Insta-Pro extruders would be considerably less than originally anticipated

Efforts were made to determine the actual duty rate by reading government regulation books on import tariffs The details in these books were not specific enough to identify a classification for extrusion equipment leading one to believe that any decision on tariff charged is dependent on the customs official consulted An approximation of 50% for the tariff was estimated from interpretation of information available in these books Because of the uncertainty in selecting a classification

and in understanding if there were any special rulings, additional clarification needs to be made to ascertain the exact tariff for the extruders

Based on a 50% importation tax, the cost for the Insta-Pro extruders would be as follows

1	2 Insta-Pro 2000 extruders	Rs	1 875 000
2	Importation tax at 50%		937,500
3	Total Equipment Cost		2,812,500
4	Installation		10,000
5	Total Alternative Cost	Rs	2,822,500

7 2 Alternative B - Spectoms Engineering, Ltd Extruders

7 2 1 Descriptive Information

Spectoms Engineering, Ltd , Purshottam Estate, Bahucharji Road, Baroda, Gujarat State has recently (within the last two years) begun fabrication of an extruder and supporting ancillary equipment The design is based on a Wenger X-25 extruder Certain ancillary equipment, such as a dryer designed to be compatible with the extruder, is also manufactured by the company

This company has been making replacement parts for the Amul Dairy extruder for the past eight years They have been fabricating mostly wearable parts such as the screw and barrels for the extruder as well as other parts as required This work helped them to gain experience and knowledge in extruder parts manufacturing Based on this experience the company has designed, fabricated and sold an extruder to a private food processing company to make textured vegetable protein (TVP) This extruder has been in operation for one year Data were not available from the extruder manufacturer on its operating performance

A limited number of test runs have been made on the above machine using cereals blended with legumes as raw materials Samples from these runs were available for examination and were found to be uniform in expansion degree of cook and size The texture of the extrudate was similar to most cereal products extruded at high moisture and moderate temperatures Spectoms indicated that the materials were extruded within the moisture range of 28-32%, but the discharge temperatures were not known To utilize the extruder for cereal processing further testing and optimizing of extrusion conditions would be required to assure desirable product characteristics The operational moisture range of the extruder appears to be large enough to permit a drier extrusion and higher expansion, but tests would be required to confirm this fact and the role these changes would play on physical nature of the finished product

Spectoms is now working on a design similar to a Wenger X-175 plus ancillary equipment to support the extruder in an effort to provide a range of extruder capacities A unit is currently being built for Nobel Soya House in Bhopol who also own and operate the small extruder mentioned earlier for making TVP

Spectoms sells the extruders complete with feeder, preconditioner cutter, and drive Ancillary equipment such as steam generator units must be user purchased, however Spectoms will assist in their selection Additionally, the company offers a line of dryers to match the capacity of their extruders These dryers use a system heat exchanger (Steam tubes) and are configured for three pass operation, the third pass being a cooler

The company also makes a line of animal feed mills, pellet mills continuous baking plants for cookies and biscuits, corrugated storage tanks, salt iodization plants, as well as other specialized equipment upon request

Table I gives more specific information on the extruders and ancillary equipment

Table I Information on Spectoms Extrusion Equipment

1	Unit Size Designation	Small	Large
2	Capacity kg/hr	150 - 250	650 - 800
3	RPM	360	360
4	L/D	12	12
5	Power supplied, kW	50	Unknown
6	Extruder Cost(1), Rs	800,000	1,800,000
7	Dryer	450,000	1,600,000
8	Steam generator	200,000	550,000
9	Installation	150,000	300,000

(1) Extruder, feeder, preconditioner, cutter, drives

Unlike the Insta-Pro, which is a dry type extruder (12-18% wb) the Spectoms extruder operates within a higher moisture range (18-35%) The higher moistures necessitate provision for moisture removal after extrusion to assure dry product Since the extruder operates like a Wenger, steam is required to assist in cooking and control of the extruder The net result is a more complicated yet more versatile process than the Insta-Pro extruders

In order to more fully understand the operation of the Spectoms extruder in actual conditions, a trip was made to Bhopol, to visit Nobel Soya House, Ltd They have been operating the small extruder for approximately one year, generally 8-10 hours/day, to make a TVP product which is sold to the GOI for use in military foods Also they have made shaped foods for use as pet foods and a few products for human use which were made from cereals in combination with legumes Information on

production of the cereal based products was not available since data were not recorded during the trials

TVP is extruded at a rate of 150 kg/hr and a temperature of 90 110°C Expansion and texturization of the product was good Nobel Soya personnel judged extruder made TVP product as nonuniform Product made in the extruder and examined during the visit did not have a sufficient amount of uniformity variation to be of concern It is normal to experience variation in the extruded TVP pieces even when using the best of equipment, therefore the degree of nonuniformity experienced in TVP production should not be a concern for either Nobel Soya or for cereal based products to be made in the Godhra plant Plant staff indicated that the extruder could produce very consistent products from the same lot of soy flour, however, variations in product quality were common when using different lots of the raw material Consistency evaluations were based on results from moisture, bulk density, NSI, water absorption and microbiological plate count determinations

Maintenance of the Nobel Soya extruder has been done on a routine basis however, the frequency of repair and extent of parts replacement was not known The screw was replace once since start-up indicating a fairly low wear resistance of the metallurgy The "worn" screw when examined did not appear to be worn sufficiently to merit replacement The e ception was the conical screw section at the end of the screw The conical section showed significant wear and was reported to be replace after 200 tons of production

Some mechanical problems were also being experienced with the extruder The primary problem was a need to frequently service the bearings supporting the extruder screw It was reported that the rear bearing becomes loose with operation causing the screw to have an eccentricity Upon inspection, it appeared the problem was due to a lack of exact tolerances for the bearing fit Solutions to the problems were

discussed Other minor problems have been experienced but could be solved without major cost or down time to the plant

Overall, Nobel Soya House was pleased with the extruder, its operation and ability to make their TVP product The company confirmed their intent to purchase a larger unit from Spectoms in the future

- Rationale for Selection

Indigenously made equipment has been a primary requirement for most projects in India Given the desire to have extrusion in the Godhra plant coupled with the indigenous fabrication requirement make this alternative worth strong consideration Upon closer analysis, several advantages can be identified including

1 High quality extruded products can be manufactured Better control of the product quality with regards to solubility and dispersibility for a weaning food, and texture, shape, and size for finger foods can be achieved than with the Insta-Pro
2 Flexibility in formulation exists The nature of the extruder permits cooling and heating as required, making it possible to extrude a number of products not possible with extruders that operate under drier conditions
3 Locally made in India The extruder is made locally making access to replacement parts and technical backup readily accessible (within 75 km of the Godhra plant)

Disadvantages of this alternative may be summarized as follows

1 It needs to be demonstrated that the Spectoms extruder will satisfactorily process raw materials selected for the weaning food since only TVP has been made on the extruder continuously Therefore, there is a certain risk involved with this alternative by assuming a satisfactory product can be made

2 The higher moisture extrusion necessitates the purchase of additional equipment such as a boiler, dryer, etc which increases the initial investment and to a minor extent operating costs

3 Some modification to the existing process layout would be required to utilize this machinery

4 Upgrading of some equipment already in place or ordered may be required to be compatible with extruder requirements

There appears to be two options within this alternative which may be suitable for replacing the two Insta-Pro extruders As prescribed by Harper and Jansen, the Godhra plant would require a capacity of 6,600 MT/year Based on the manufacturer claims, the larger Spectoms extruder would provide enough capacity to meet the anticipated production goals of the project If the larger machine is capable of 800 kg/hr, then 344 days of continuous production would be required at 100% efficiency to reach the production target The above efficiency may be unrealistic and an 80% efficiency could be assumed which would allow production of 5 300 MT for the year The additional quantity of food (1300 MT) might be achieved by adding milk powder, sugar, or other preprocessed foods after extrusion

It should be noted that the capacity for the Spectoms extruders was based on TVP production Typically, extruders have lower capacities when making TVP then making cereal/legume blends It can be anticipated that the actual production from the extruder might be higher for the weaning food product than 800 kg/hr This fact would have to be determined through additional testing

The large extruder would permit production from one machine While one machine makes the operation more sensitive to down time of the extruder, it is no more sensitive than down time caused by any other piece of equipment in the extrusion line Advantages of one extruder over multiple units include fewer maintenance problems, less inventory of parts and uniformity of product It is possible to have considerably

different products from two extruders running side by side using the same raw materials unless careful attention is paid to their operation Differences can be attributed to operator error and/or improper maintenance to name a few causes A single extruder operation minimizes these problems

A second option is multiple Spectoms small extruders It is estimated that four small extruders would be required to meet the capacity of the plant Cost for this option can be minimized through purchase of the larger dryer and boiler unit available as opposed to several small units

7 2 3 Implementation of Alternative

Implementation will be discussed with respect to the two options within this alternative since each has special requirements

Option 1 - Large Extruder

Installation of the larger extruder would be relatively simple since it could be installed in the same location as that planned for the Insta-Pro extruders in the plant Provision would have to be made in the design to accommodate the dryer and boiler units A sketch of the processing area as originally designed is shown in Figure 1 Figure 2 gives possible changes for the plant layout if the larger Spectoms extruder is selected

While Figures 1 or 2 are not detailed drawings, effort was made to block in processing sections of the plant as noted (to scale of 1 cm = 1 m) Headroom in the plant available for installing the extruder is 4 meters and therefore does not present a problem with plant layout changes due to equipment changes The specified surge tank above the extruder could be used to feed the large extruder and one down spout could be eliminated A means of conveying the extrudate to the dryer would have to be provided A belt conveyor would be the best choice for this process step Finally the dryer could be installed as shown with some means provided to move the cooled material to the grinding/blending area More study and planning of the plant layout with respect to required

charges to accommodate the Spectoms equipment might result in a more efficient use of existing space in the process area than that proposed in the accompanying drawings

Option 2 - 4 Small Extruders

Figure 3 gives an idea of how the four extruders might be placed in the processing area Again, size and floor area requirements for the machinery were estimated and more efficient use of floor area might be found through careful planning The primary changes required for this configuration are

1 Individual surge tanks for each extruder will be required and must be purchased
2 A means to convey and distribute raw material to each surge tank is required
3 A conveyor to move the product from the extruders to the dryer would be required Preferably, a belt conveyor would be used for this application
4 A dryer/cooler unit would be necessary

For both options, the horizontal pellet cooler and possibly the pneumatic conveying equipment between the cooler and the extruder would become unnecessary and could be sold or used for some other application in the plant

7 2 4 Economics of Alternative

Costs for the equipment as estimated by Spectoms Engineering are listed in Table I The estimated cost for equipment and changes required to implement the two options of this alternative are summarized in Table II

Costs for conveyors, surges etc were estimated from information available on the Godhra plant equipment A contingency cost of 5% was added to the total to insure funds are available for upgrading or

modifying existing equipment to make it compatible with the extruder input or output requirements Installation cost was based on estimates given by Spectoms plus additional amounts were added to cover unexpected costs The estimate for installation was considered to be higher for the small extruder due to the multiple installation of utility lines and equipment for the plant

Table II - Estimated Cost of Two Options in Alternative B

	Item	Large Extruder	4 Small Extruders
1	Extruder	Rs 1,800 000	Rs 3,200 000
2	Dryer	1,600,000	1,600,000
3	Boiler	600,000	600,000
4	Extruder/Dryer Conveyor	60,000	180,000
5	Additional Surge Tanks	- -	120 000
6	Miscellaneous Conveyors	- -	30 000
7	Electrical	100,000	225,000
8	Contingency (5%)	208 000	297 000
9	Total Equipment Cost	4,368 000	6 253 000
10	Installation Cost	350,000	500 000
11	Total Option Cost	4,718,000	6 753,000

7 3 Alternative C - One Spectoms Small Extruder

7 3 1 Descriptive Information

While Alternative B proposed two viable options for the plant the cost to implement them was found to be high Alternative C examines what can be purchased from Spectoms Engineering assuming that the budget is limited to the sum required to purchase the Insta-Pro extruders before importation tax For a technical description on this alternative see Alternative B, Section 7 2 1

7 3 2 Rationale for Selection

The extrusion equipment manufactured by Spectoms Engineering meets criteria for being suitable for installation in the plant and is made in India Since the economic analysis in section 7 2 4 resulted in high costs there may not be sufficient funds in the project to purchase one of these alternatives Another approach would be to determine what allocated funds could buy

A minimal system for the plant that could be purchased from Spectoms would be an extrusion line using only one small extruder The advantages for selecting one small extruder are

1 Maintain the objective of using extrusion in the plant
2 Still provides an option to buy local equipment if importation is found unsuitable
3 Locally available parts and technical back-up
4 The purchase cost would stay within budget

The primary disadvantage of this alternative would be a reduction to about one-fourth that of the design capacity specified by Harper and Jansen Using a throughput of 250 kg/hr and 80% efficiency over 344 days, only 1,650 MT of processed material would be produced It might be possible to formulate the product so that the extruder production would represent, for example, 50% of the production This production could be supplemented by adding either preprocessed food items to bring the capacity of the plant to approximately 3,300 MT per year While this is not ideal capacity, it still enables production to begin in the plant

7 3 3 Implementation of Alternative

Assuming that the small extruder and ancillary equipment would be purchased for the project, the modifications required for installing this equipment would be no different from those required in Alternative B for the single large extruder The only difference would be in the floor space required to accommodate the machinery

- 3 4 Economics of Alternative

Cost for this alternative is estimated below In general the cost is lower due to smaller scale equipment

1	Extruder	Rs	800,000
2	Dryer		450,000
3	Steam Boiler		200,000
4	Extruder/dryer Conveyor		60 000
5	Additional Surge		- -
6	Miscellaneous Conveyors		- -
7	Electrical		- -
8	Contingency (5%)		75,000
9	Total Equipment Cost		1,585,500
10	Installation		150,000
11	Total Alternative Cost		1,735,500

- 3 5 Discussion

It should be pointed out that if the project anticipates funding additional equipment for future expansion it may be worthwhile to consider some long term plans which would govern purchase of certain equipment at this time Options for consideration might be

1 Systematic addition of new small extruders to increase capacity Provision should be made to accommodate these purchases by installing larger conveyors, dryers, etc during the initial stage of the project rather than additions in the future Considerable savings would be realized over the long term

2 Replacement of the small extruder with the larger extruder Again, it may be appropriate to purchase a larger dryer, boiler, and conveyors during the initial stage rather than in the future

7 4 Alternative D - Roasting/Grinding/Mixing

7 4 1 Descriptive Information

Drs Harper and Jansen determined that the roasting/grinding/mixing process was suitable for use in making RTE food products They also determined that the addition of cleaning, destoning and grinding equipment would enable the process to accept whole grains for roasting The current process flow for the extrusion plant provides suitable front end equipment to clean, destone dehull, grind, and mix raw materials to feed to a roaster Additionally, a number of process steps exist in the designed extrusion process line such as continuous cooling further milling for size reduction, and blending which would be complementary to the roasting process

7 4 2 Rationale for Selection

Attempts have been made to find alternatives that would replace the Insta-Pro extruders with other extrusion equipment The extrusion options available are limited so other types of processing need to be considered The most suitable is the roasting/grinding/mixing alternative Advantages for this process include

1 The technology is indigenous making parts and technical back up available
2 The project personnel is familiar with the technology and products it can make
3 A minimal amount of modification would be required to install and use the roasting technology
4 The cost for this alternative is low

There are some disadvantages in selection of this alternative including

1 It needs to be demonstrated that the roasting/grinding/mixing technology can make a suitable weaning food with good solubility and

dispersibility Some risk is taken in assuming that the technology can make these foods satisfactorily

2 Foods such as snacks and finger foods can not be made with the process

3 Roasting typically makes a product with limited solubility and containing gritty particles when hydrated in water The gritty nature of the product may limit the use of the product to older children

7 4 3 Implementation of Alternative

Sufficient room exists in the building to accommodate the roasting process The roaster could be installed in place of the extruders at an appropriate height so that the discharge from the roaster could be easily conveyed to the cooler The process flow for the extruder line is shown in Figure 4 and the line with the roaster is shown in Figure 5

Specific modifications required to implement this change include

1 A means of distributing the raw flour to the two roaster units
2 A heating system to supply energy for cooking to the roasters
3 Transitions and miscellaneous items to assist in the collection and removal of the cooked products from the roasters
4 An upgrade for the horizontal cooler would be necessary to accommodate the finer particles required for the process

7 4 4 Economics of Alternative

Based on the design of the Chandrapur plant and the estimated requirements to install the unit in the extrusion line, an estimate of the costs for implementing this alternative in the Godhra plant can be made

1	Stainless steel roaster	Rs	300 000
2	Oil fired heating system		380,000
3	Distribution system for raw material		45 000

4	Transition and Miscellaneous	105,000
5	Cooler upgrade	250 000
6	Contingency (5%)	49,000
7	Total equipment cost	1,029,000
8	Installation	90 000
9	Total Alternative Cost	1,119 000

7 5 Other Alternatives

Two other alternatives were pursued during the investigation which potentially meet the specific criteria used to define those mentioned above

7 5 1 Brady Extruders

Brady Extruder Corporation has a large project in the Punjab State in which their extruders are being used to heat stabilize rice bran Brady's managing group in India Food Technology Inc (FTI) franchises extruders for use in stabilizing bran, but does not sell machines for this use

Some effort has been made by personnel in the project to contact FTI, but only a limited amount of correspondence could be found No clear evidence existed in available documentation to indicate that FTI would sell extruders or was making the extruders locally Attempts were made to contact FTI however, the Managing Director had left India and no other individual could respond to inquiries Therefore, it was not possible to determine if this alternative had any merit foi consideration in the final analysis

The Brady extruder represents a suitable alternative, if available, as a replacement for the Insta-Pro extruders Reasons for this fact include

1 It is capable of processing cereal/legume combinations for use in weaning foods

2 It has a capacity similar to that of the Insta Pro extruders

3 It is a dry type extruder like the Insta-Pro

4 It is low cost

5 It would require a minimum amount of modification to the process line to implement

While the Brady is a suitable replacement there are some disadvantages in its selection including

1 The plant would be limited to weaning food production since it is not possible to produce snacks or finger foods with the Brady

2 Recent design changes to the extruder might diminish its suitability for use in cereal processing Changes to the extruder were done to facilitate rice bran stabilization and not cereal processing Of primary concern would be the change to the adjustment mechanism for the cone/cup clearance When processing cereals, an ability to make large adjustments quickly to this part of the machine is essential when the extruder is not operating properly The current design does not provide for rapid adjustment

3 The new Brady extruder has not been tested with cereal blends Therefore, some risk exists in using the extruder without data to support is capability to process raw materials similar to those expected to be used in products made in the Godhra plant (which were assumed to be cereal/legume combinations)

Implementation of the Brady alternative would be fairly easy only requiring slight modification to the existing layout Because of the irregular shapes and sizes of extrudate pieces from the Brady it might be necessary to replace the pneumatic conveyor between the extruder and the cooler with a belt conveyor Some slight changes in equipment location would be required also

The cost to implement this alternative can be only approximated as

1	2 Brady Extruders	Rs	600,000
2	Importation Cost (50%)		300,000
3	Belt Conveyor		180 000
4	Electrical		60,000
5	Contingency (5%)		57 000
6	Total Equipment Cost		1,197 000
7	Installation		20,000
8	Total Alternative Cost		1,217 000

7 5 2 Used Equipment

It is typical in many countries to find used or unused equipment that has become surplus mainly due to project failures or a lack of part sufficient to repair and maintain the equipment It is difficult to evaluate, during this short term assignment, the extent to which such equipment might be available in India or the associated costs for such equipment The idea is mentioned in this report for consideration should the other alternatives presented be found inappropriate

The Soybean Research Production Association in Bareilly was rumored to have stopped producing products and the factory decommissioned The equipment in the plant included a Wenger X-25 unit which might be considered as an alternative parallel to Alternative C discussed earlier Bishop Stanley Downes was contact to determine the current status of the plant Bishop Downes indicated that the Wenger had been disassembled and was no longer in possession of their group Had the unit been available it may have been possible to purchase it for use in Godhra or possibly receive it gratis

8 0 Discussion

To evaluate the alternative presented in this study, an analysis similar to that used by Harper and Jansen is presented They used a point by

point evaluation of various features rating each on a scale of 1 10 10 being the highest or best rating Table III gives a comparison of alternatives with ratings on the criteria used for selection

Alternatives B, C and D represent indigenous technologies meeting the criteria necessary for consideration in this study No other potential source for cooking equipment was found

The extent of maintenance required for the extrusion equipment made in India is unknown Therefore, a conservative rating was given to these alternatives which may prove to be lower than merited All extruders will require frequent maintenance because of wear and in general do not get the highest rating The roasting/grinding/mixing technology of Alternative D would require the least maintenance

Capacity was rated on the basis of achieving a yearly production of 6,600 MT The Spectoms extruders may not be able to achieve the yearly capacity without supplementing with preprocessed foods Little information was available on their operating capacity with cereal blends

Each process alternative must fit into the existing design for the plant Only the Insta-Pro extruders will avoid redesign of plant flow and changes in equipment layout Both the roasting and Brady options would be simple to implement requiring little additional equipment and change to the plant layout Spectoms extruders would require more modifications to the design to enable installation of the equipment required

Time for commissioning the extruder alternatives are best estimates based on in-country discussion, previous quotations on equipment, and knowledge of the industry It could be up to one year before any option is commissioned at the plant should lengthy approvals or clearances be required prior to purchasing the equipment

Table III Comparison of Alternatives for Replacement of Insta Pro Extruders in the Godhra Plant
[10] - Highest Rating [1] - Lowest Rating

	Criteria	Alternative A Insta-Pro Extruders	Alternative B Option 1 Large Spectoms Extruder	Alternative B Option 2 4 Small Spectoms Extruders	Alternative C 1 Small Spectoms Extruder System	Alternative D Roasting/Grinding/ Mixing	Brady Extruders
A	Indigenous Equipment	[6] Available in India Requires importation	[10] All equipment made in India	[10] All equipment made in India	[10] All equipment made in India	[10] All equipment made in India	[6] Available in India Requires importation
B	Maintenance	[7] Extruder Suscept able to wear Rebuilding parts after 1000 1500 hours operation	[5] High wear of certain parts on extruder Replace ment of key parts every 200 MT	[5] High wear of certain parts on extruder Replace- ment of key parts every 200 MT	[5] High wear of certain parts on extruder Replace- ment of key parts every 200 MT	[9] Maintenance minimal	[6] Extruder susceptable to wear Replacement of key parts every 200 hours and screw every 1000 1500 hours
C	Capacity	[10] Capable of meet ing capacity requirements at 80% efficiency	[8] Capable of meet ing capacity requirements by adding prepro cessed foods to extruded material	[8] Capable of meet ing capacity requirements by adding prepro cessed foods to extruded material	[3] Not capable of capacity require ments Adding pre processed foods may permit 50% of target production	[10] Capable of meeting capacity requirements	[10] Capable of meeting capacity requirements
D	Ability to fit existing process	[10] No change required	[8] Some modification and relocation of equipment required	[6] Several modifica tions to plant design required	[8] Some modification and relocation of equipment required	[8] Some modifica tion and relo cation of equip ment required	[9] Minor modification required to plant layout
E	Energy cost	[5] All energy from electricity	[5] All energy from electricity	[4] All energy from electricity	[5] All energy from electricity	[9] Energy from fuel oil	[7] High power requirement from electricity
F	Time to Commission	[9] 4 6 months	[7] 4 8 months	[5] 8 12 months	[6] 6 9 months	[10] 3 6 months	[9] 4 6 months

Table III (Cont d)

	Criteria	Alternative A Insta Pro Extruders	Alternative B Option 1 Large Spectoms Extruder	Alternative B Option 2 4 Small Spectoms Extruders	Alternative C 1 Small Spectoms Extruder System	Alternative D Roasting/Grinding/ Mixing	Brady Extruders
G	Number of operators required	[8] Requires skilled mechanical elec trical and quality control operators	[8] Requires skilled mechanical elec trical and quality control operators	[8] Requires skilled mechanical elec trical and quality control operators	[8] Requires skilled mechanical elec trical and quality control operators	[8] Requires skilled mechanical elec trical and quality control operators	[8] Requires skilled mechanical elec trical and quality control operators
H	Personnel requirements	[8] Constant moni toring of opera tions required	[8] Constant moni toring of opera tions required	[6] Larger number of operaotors re quired due to more extruders	[8] Constant moni toring of opera tions required	[8] Monitoring of operations required	[6] Constant moni toring of opera tions required
I	Experience in India	[7] Insta Pro exper ience available but limited	[3] No machine in operation no experience	[5] Only one machine in operation limited experience	[5] Only one machine in operation limited experience	[9] Extensive ex perience and back up avail able	[8] Many machine operators in Punjab plus local U S counterpart available
J	Product versatility	[8] Weaning foods snacks and finger foods possible	[9] Apparent versa tility similar to Wenger	[9] Apparent versa tility similar to Wenger	[9] Apparent versa tility similar to Wenger	[4] Limited flexi bility finger or snack foods cannot be made	[5] Limited flexibility only weaning food can be made
K	Alternative risk	[9] Processing form ulas with no oil cessing formula tion with no oil	[4] Higher risk due to limited ex perience with machines	[5] Higher risk due to limited ex perience with machnies	[5] Higher risk due to limited ex perience with machines	[10] Capabilities known	[8] Risk in processing if formulation con tains less than 4% oil
L	Alternative Cost	[9] Meets budget criteria but duty required	[5] High cost com pared with Alter native A	[3] Highest cost of options	[8] Meets budget criteria	[9] Meets budget criteria	[9] Meets budget criteria but duty required

Personnel requirements are similar for all alternatives with the exception of the second option of Alternative B More personnel were estimated for monitoring and operating the four small Spectoms extruders It is estimated that at least one more, but more likely two additional operator would be required to insure continuous operation of the plant

Experience with all extruders in India is very limited Three Insta Pro extruders were reported to have been imported into India and will be in use shortly Personnel using these machines might be consulted for purposes of assistance when problems arise Operational information on the Spectoms extruder is limited to Nobel Soya House in Bhopol and would be available to back-up operations Roasting is most widely used and experience has been gained in the project, giving a firm foundation in its operation and the local availability of expertise to draw upon for assistance

The versatility of each process was evaluated by each machine's capability to make different products Extrusion give the greatest flexibility with exception of the Brady The Brady is only capable of making a randomly shaped chip which would not be suitable for snack or finger foods

There is some risk with every alternative since each has disadvantages Most of the risk for each alternative centers on its ability to manufacture a suitable food continuously If a formulation for the product were available, evaluation on the extent of the risk would be made As such, a general approach to evaluating the risk was made assuming product would be formulated from cereals in combination with soybean

The lowest cost alternative could be in finding a used piece of equipment that a benefactor would be willing to donate Chances are minimal that a used piece of equipment is available, so further evaluation is not merited

3 1 Product Manufacturing Cost Differences

Manufacturing costs were calculated specifically for operation of each alternative and did not include total plant costs It was assumed that the only change in manufacturing cost would be due to requirements associated with the different extruders or roasting Therefore the cost calculated and given in Table IV represent incremental cost changes associated with the different processing alternatives

Table IV - Estimated Operating Cost Comparisons Between Alternatives

Alternative		A	B1	B2	C	D	Brady
Capital Cost		2541	5898	6753	6942	1119	1123
Manufacturing Cost							
A	Labor	75	63	150	200	62	75
B	Utilities	225	225	336	120	230	300
C	Repair/Main	75	50	40	160	38	75
D	Depreciation	35	66	94	24	16	16
Total Cost		410	344	620	504	316	466

Notes for Table IV

1 Figures are in 000's Rs /MT for capital cost all others in Rupees

2 Labor requirements for extrusion are one man per machine plus one per two machine for relief at a pay scale of Rs 25/hr

3 Roaster labor requires 2 men plus one relief

4 Utilities - Electrical costs at Rs 2/KWH Heat energy from steam or electric equal to twice extruder drive motor power requirement for machines needing ancillary heat

5 Repairs and maintenance - Dry type extrusion = Rs 75/MT wet type extrusion = Rs 40/MT

6 Depreciation - Straight line, 10 years, 300 days per year at 24 hours per day

The costs are merely estimates of operation and do not necessarily represent actual figures for the plant The figures given for the cost of manufacturing products are estimated to have an accuracy to within 10 15% Thus, there is enough error in the calculation to make the difference between the high and low estimates insignificant and therefore it can be concluded there would be no significant manufacturing cost difference between the alternatives considered

9 0 Other Issues

9 1 Dehulling

To date, action has not been taken to order equipment necessary to dehull grains used in the plant Effort should be made to order the equipment since it is recommended for a weaning food Primarily, dehulling will

1 Remove the outside layer of seeds, reducing the fiber level in foods which is a requirement for infant and young children Infants have a low tolerance to crude fiber in their diets
2 Reduce the incidence of bacteria and molds in the product

The technology for dehulling is currently available in-country Under license to Henry Simon, England, a local company AUROSIMON Auroville India, is now manufacturing grain processing equipment A unit suitable for dehulling is made in India and is called a Sentry Impact Aspirator MK 4 The unit has sufficient capacity and can provide a high quality dehulled product for use in the plant

9 2 Weigh Blender

The design of the Godhra plant call for a blender to be installed for mixing raw ingredients prior to extrusion While the design concept is good, t is necessary that the blender be mounted on a scale to insure that the proper quantities of each raw material are added and thus provide a consistent product to the extruder Without a scale under the blender it is difficult to measure the quantity of ingredients

discharging from the surge tanks into the blender It is recommended that a scale mount be purchased for the blender

9 3 Boiler Steam Generator

The analysis for this study did not address the installation of equipment to provide heat or steam to the extruder, dryer or roaster For those alternatives requiring the above equipment space will have to be allocated in the plant to install the boiler or hear unit Sufficient space exists in the plant to install the unit Figure 6 gives a plan of the building and indicates potential locations for the boiler Ideally the unit should be installed near the equipment to minimize heat and pressure losses in lines

10 0 Conclusions

10 1 A method for paying the taxes for imported extruders has delayed the implementation of the Godhra plant USAID is unable to pay the duty and the COI has no funds available and will not waive the import tax for the project Therefore, it was necessary to explore other processing alternatives to enable the project to continue There is no clear understanding of what the tariff for an extruder should be since rates were reported different depending on the source One could conclude that the tariff will be dependent on the assessor and the way the request for evaluation is presented

10 2 The building erected for the weaning food plant in Godhra is 90% complete The building was satisfactorily designed and had been erected with care to insure that it met criteria to be used as a food plant The size of the building and especially the process area has sufficient space to enable process changes without any building structure modifications

10 3 Both imported and indigenous extrusion equipment was found suitable to use in manufacturing weaning food snacks, and finger foods Imported extruders such as the Insta-Pro have the advantage of minimizing the

amount of modification required to the plant design They reduce the uncertainty of producing a satisfactory product continuously, are the choice of process by project personnel, staff and officials in the project, and they are low cost Their main disadvantage is the requirement of importation taxes Technical back-up and replacement parts are not readily accessible without importation

Indigenous extrusion equipment made in India have the advantages of providing the back-up and replacement parts from indigenous sources and provide flexibility in product formulations and processing Disadvantages include low capacity, high cost, and a higher level of uncertainty in being able to make a satisfactory product continuously

10 4 Extruders made by Spectoms Engineering, Ltd have a design similar to the Wenger extruders The extruders are built reasonable well, but have some mechanical problems which have been reported by equipment users The problems seem to be associated with an inadequate fabrication techniques more so than the design Therefore, it may be concluded that mechanically, the extruders are designed adequately but some refining of the fabrication would be required to avoid similar problems

High quality products can be made with these extruders using higher raw ingredient moistures requiring product drying Testing would be required to refine operations of the equipment and to achieve the desired product The extent of this testing would be dependent upon the specific formulations to be used for the project

10 5 Costs for the local extruders are high due to the need for ancillary equipment such as steam generators, dryers, additional conveyors, and upgrade of other equipment to support the extruders The higher cost may also be attributed to the more complicated fabrication techniques used to make the machines compared to extruders like the Insta-Pro

10 6 Roasting/grinding/mixing is a technology that can be used in the Godhra plant To implement the technology only roasting and heating equipment would have to be added All other ancillary equipment such as mixers etc is available to support the roaster

10 7 Advantages of using the roasting process include lower capital cost it is made in India and a large amount of experience exist to support the technology The main disadvantage of this process is a limitation in flexibility of products other than a cooked relatively insoluble flour which hydrates only with some boiling in water

10 8 The Brady extruder may be an alternative to consider since it is low cost, would enable the use of extrusion in the plant and would easily fit into the process design Limitations exist in formulating since a minimum of 4% oil would be required to minimize operational problems Since the extruder cannot manufacture shaped food, production would be limited to a weaning food in dry powder form

10 9 Purchase or used or unused imported equipment in India represents an option with very low probability It is difficult to find the equipment and if found, may not have sufficient capacity or useful life to be considered for the project

10 10 The analysis of alternatives indicated that the most attractive alternative would be the roasting process This alternative minimizes capital cost and maximizes the use of indigenous technology The premium paid for using this technology is the inability to make snack and finger foods and the processing of a weaning food with limited functional properties

10 11 The second most attractive alternative requires purchase of the Insta-Pro extruders The premium paid for this option is the cost of duty (Rs 938 000) Since USAID will buy the equipment, consideration might be

given to waiving the duty in which case no premium is paid for this option

10 12 If purchasing a local extruder is desired, the best alternative is the purchase of a Spectoms large extruder The premium paid is an additional Rs 2,200,000 required to buy the equipment when compared to the Insta-Pro extruders and the uncertainty associated with selecting equipment that has little track record

10 13 The purchase of a small Spectoms extruder was the lowest cost of any extrusion equipment alternative The premium paid with this option would be a reduction in desired capacity of 75% and thus a reduction in the number of beneficiaries

11 0 Recommendations

11 1 It is recommended that the project continue to woik towards an operational plant in Godhra and to resolve the current importation problem The need exists in the Panchmahals district for a production facility to support the food component of the ICDS project Abandoning the investment in the plant of up to Rs 3,000,000 is not practical Abandoning the project would also strain relations between groups participating in the project

11 2 It is recommended that the duty be paid or a method found to waive the duty for the purchase of the Insta-Pro extruders There is some uncertainty on what the actual assessment may be which complicates resolution of the issue Eliminating the tax requirements from the project would result in the least cost for the Government of India Government of the State of Gujarat, and USAID It would permit the purchase of the Insta-Pro extruders giving the quickest and most satisfactory method of achieving project goals for the plant

11 3 In the absence of a resolution on the importation tax issue, it is recommended that the least cost indigenous technology which is roasting be installed in the plant Roasting can be implemented easily in the plant and would enable the production of a cooked food product which has limited utility in weaning food applications Installation of the roasters in place of the Insta-Pro extruders could be done in a manner which would eliminate the manual operations required in the Chandrapur plant Less contact with the food would mean less chance of contamination

11 4 It is recommended that consideration be given to the indigenous extrusion technology equipment if and only if the project is unable to implement either of the two previous recommendations The least cost option would be a small Spectoms extruder system with limited capacity (Alternative C) Options with greater extruder capacity (Alternative B) are only achievable through a greater expenditure of funds which apparently are not available

11 5 It is recommended that a weighing scale sized for the blender plus weight of material be purchased for the blending of raw ingredients Under the current plant design, there exist no method for weighing raw materials for each batch blended Addition of the scale would minimize labor requirements for this operation

11 6 It is recommended that a formulation for the weaning food be established to enable a rapid start up of the plant once equipment is in place There has not been any firm decision on the formulation that would be used in the plant The lack of a formulation complicated the evaluation in selecting a suitable alternative process Identification of a formulation at this time would permit some preliminary testing prior to start-up of the plant regardless of the process selected At least one operating unit of each alternative considered exists in India which could be used to test and develop products to be produced in the plant as well

as identify the operational parameters necessary to operate the machines prior to startup of the plant

11 7 It is recommended that a study be carried out to determine how an optional roasted weaning food can be made This recommendation was also made in the Harper Jansen report and repeated in this report to reinforce the importance of these tests Changes to operating parameters or the formulation may have to be made to achieve satisfactory results

11 8 It is recommended that an organization be established in India consisting of food processors and manufacturers of food process equipment Currently, it is difficult to identify food equipment manufacturers because of the physical size of India, poor communication capabilities, and lack of advertising One activity of this group might be a comprehensive survey of manufacturers to develop a data base of this information

12 0 References

1 Project Paper India Integrated Child Development Services (386-0476) USAID/India June 1983

2 Harper, J M and Jansen, G R ICDS food Processing Plant Feasibility Study August 1985

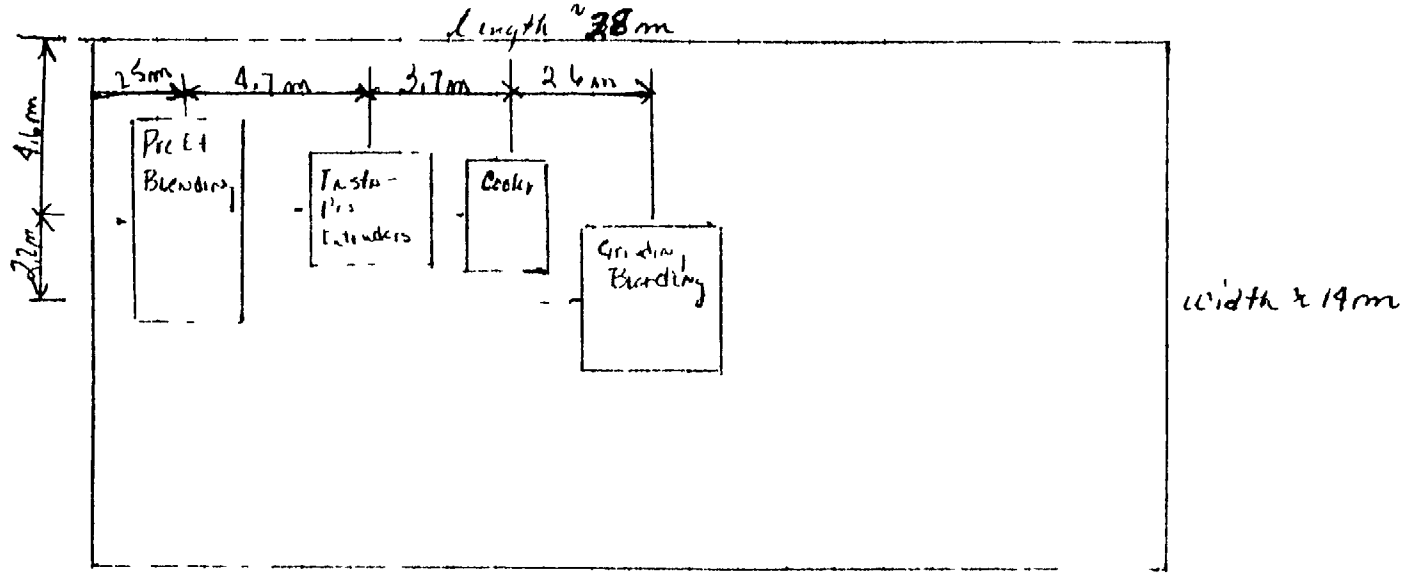
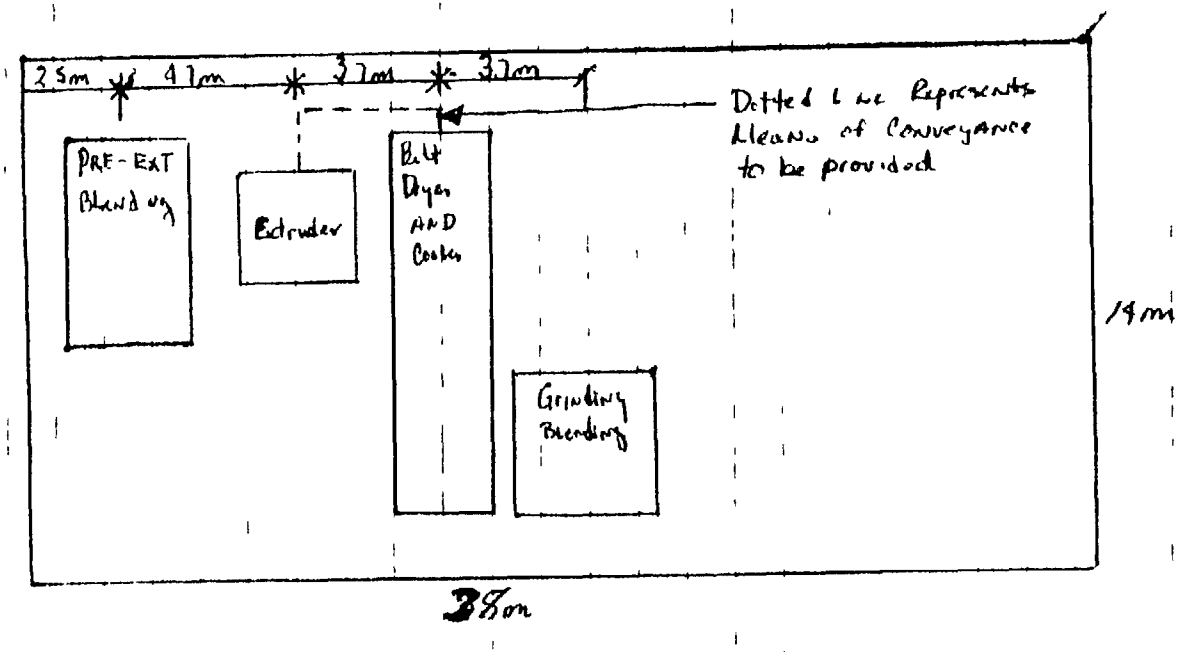


Figure 1 Original Plant Design



NOTE. Illustrative Diagram only. Detailing drawings need to be completed to ensure location and Rock Accuracy

Figure 2 Plant Design Changes for Large Indigenous Extruder

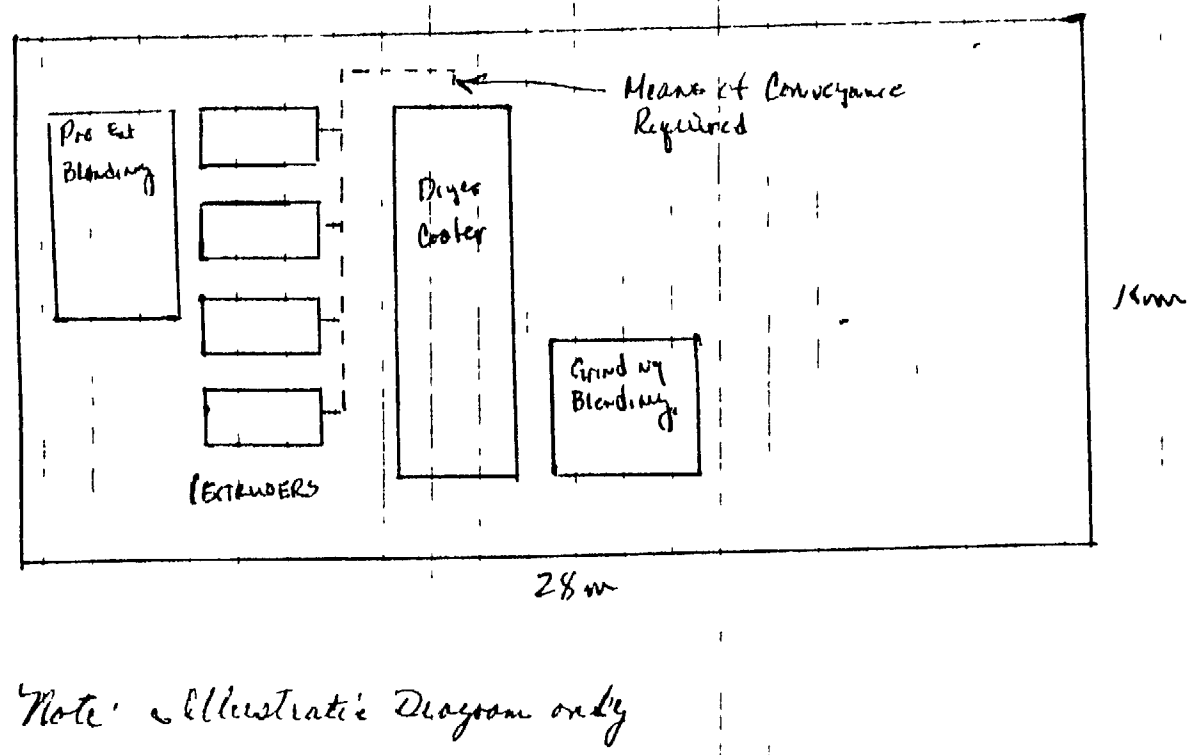


Figure 3 Plant Design Changes for Small Indigenous Extruders

Figure 4 - CURRENT EXTRUSION PROCESS FLOW

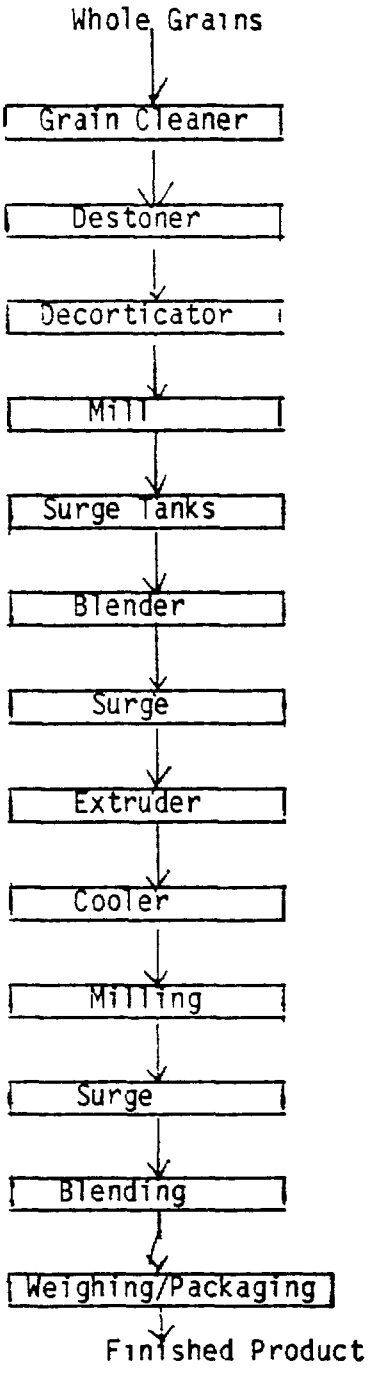
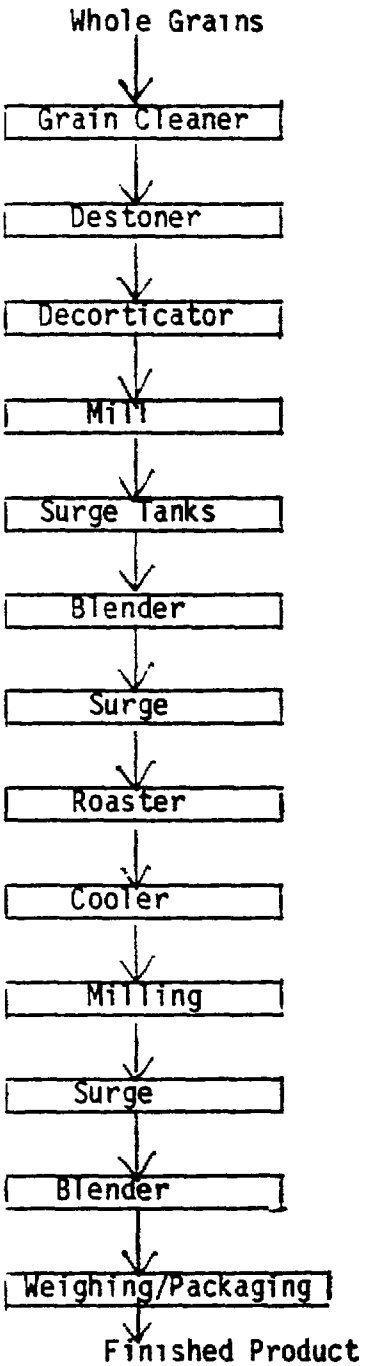


Figure 5 - EXTRUSION PROCESSING LINE WITH THE ROASTER USED IN PLACE OF THE EXTRUDER



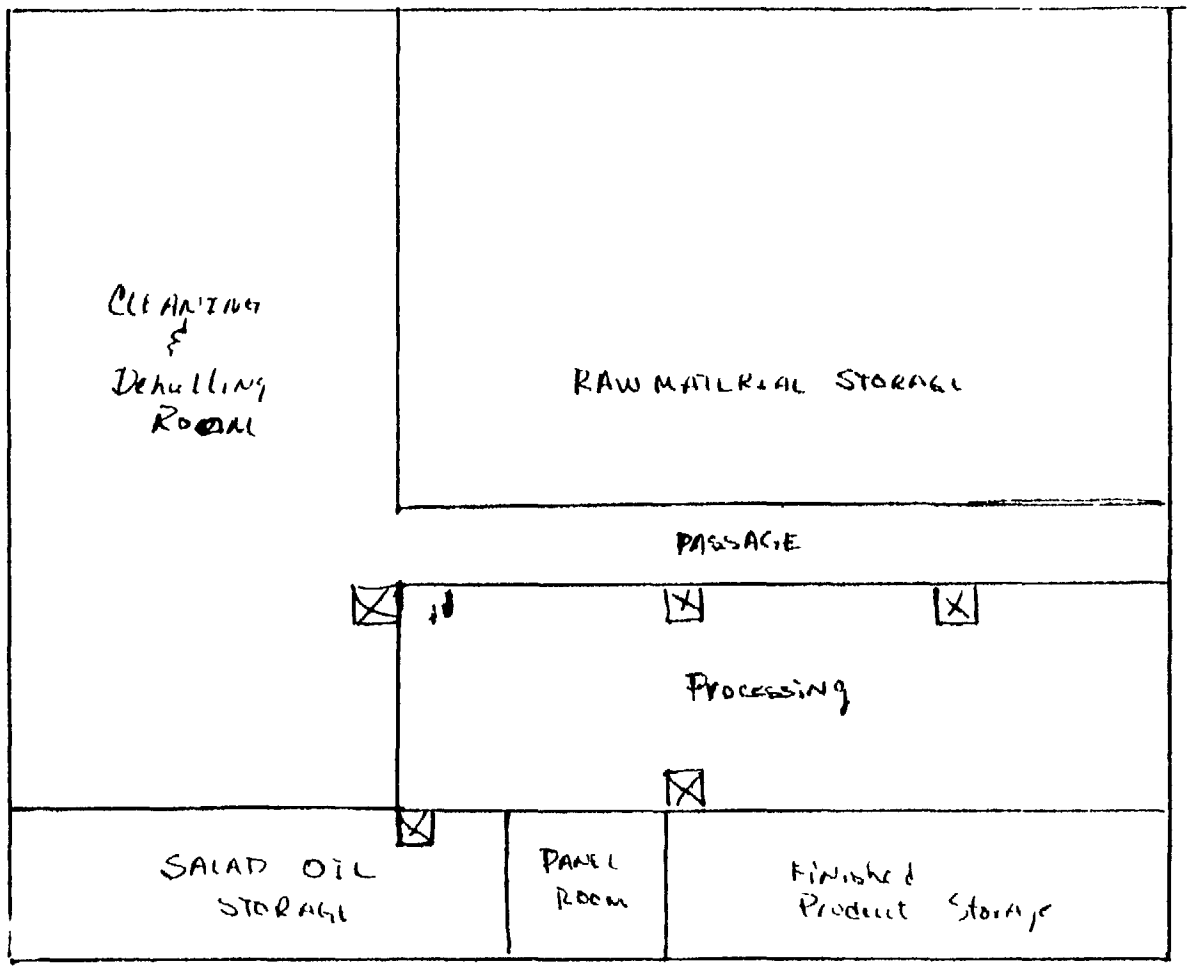


Figure 6 Suggested Plant Locations for Boiler

Appendix I

Schedule for Study on Alternatives for Extrusion in Godhra Plant

January 22	11 00 pm	Arrive Dehli
January 23	9 - 12 am	USAID briefing by Office of Health and Nutrition
	2 - 5 pm	Meeting with Ministry officials at Shastri Bhavan
	8 - 10 pm	Travel to Baroda
January 24	8 - 2 pm	Visit Godhra Plant
	2 - 5 pm	Visit Spectoms Engr , Baroda
	5 - 9 pm	Travel to Ahmedabad
January 25	8 - 3 pm	Discussions and data summarization
	3 - 5 pm	Meet with Government of Gujarat officials in Ghandinagar
	6 - 8 pm	Travel to Dehli
January 26	8 - 5 pm	Report writing and data analyzing
January 27	8 - 3 pm	USAID Briefing and Further exploration of Alternatives
January 28	8 - 5 pm	Work on report
January 29	Holiday	
January 30	9 - 11 pm	Travel to Bhopol
	12 - 3 pm	Discussion with Nobel Soya House Personnel
	3 - 5 pm	Visit Central Institute of Agricultural Engineering
	6 - 9 pm	Travel to Dehli
January 31	8 - 5 pm	USAID Briefing and Report Preparation
February 1	8 - 3 pm	USAID Briefing and Report Preparation
	3 - 5 pm	Meet with Ministry Officials for Briefing
February 2	2 35 am	Leave Dehli

Appendix II

INDIVIDUALS CONTACTED DURING STUDY

USAID/INDIA

1 Mr Spencer Silberstein, Director, Office of Health Services
2 Mr Samresh Sengupta, Project Officer, Office of Health Services
3 Mr Y P Kumar, PRJ

JOHN SNOW INCORPORATED

1 Ms Sylva Etian, Chief of Party
2 Mr George James, Administrative Officer

MINISTRY OF HUMAN RESOURCE DEVELOPMENT

1 Mr Ashok Sinha, Deputy Secretary
2 Mr Suman Nayar, Under Secretary
3 Mr K C Gupta, Under Secretary

PANCHMAHALS DAIRY COOPERATIVE

1 Mr Ravindra Mathur, General Manager
2 Mr S Sheth, Manager Engineering

GANDHINAGAR

1 Dr A A Contractor, Director of Public Health
2 Mr K V Vasavada, Field Nutrition Officer, Gujarat

BARODA

1 Mr Navin Shah, Director, Spectoms Engineering (P), Ltd
2 Mr Arvin Shah, Assistant Director, Spectoms Engineering (P), Ltd

BHOPOL

1 Mr Gopal Sharma, General Manager, Nobel Soya House, Ltd
2 Dr N Ramakrishnan, Technical Service Manager, Nobel Soya House, Ltd
3 Dr Nawab Ali, Central Institute of Agricultural Engineers
4 Mr B S Bisht, Central Institute of Agricultural Engineers
5 Mr R T Patel, Central Institute of Agricultural Engineers