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FORTIFICATION OF WHEAT WITH VITAMIN A 1/

Trip Report
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by

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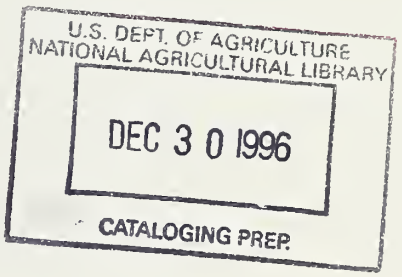

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BANGLADESH

Fortification of Wheat with Vitamin A

Contents

I. PURPOSE

The purpose of the trip was to assist Helen Keller International (HKI), a U.S.-based private voluntary organization, in studying the feasibility of developing a program for the vitamin a fortification of wheat as a major effort for alleviating vitamin A deficiency in Bangladesh. Technical assistance was to be provided to a local consulting firm for the conduct of a feasibility study to analyze the engineering and logistic considerations for fortifying imported wheat with vitamin A and having fortified wheat reach the intended recipients in the Food for Work (FFW) and Vulnerable Group Feeding (VGF) programs.

The scope-of-work for the feasibility study included:

1. Perform engineering and logistics analysis to determine the feasibility of fortifying imported wheat with vitamin A at the Chittagong silo and ensuring that the fortified wheat would reach recipients in the Food for Work, Vulnerable Group Feeding and other food distribution programs aimed at the lowest income groups in Bangladesh.

2. Identify the best place(s) to fortify imported wheat by considering Chittagong silo, other sites within the country or at the point of export in donor countries.

3. Identify and analyze alternative locations in the country and describe equipment needs.

4. Study the processing, transportation and distribution of imported wheat from arrival in ships to the point of distribution to recipients in the Food for Work, Vulnerable Group Feeding and other food distribution programs that reach the lowest income groups.

5. Determine whether a subsample of wheat could be fortified and directed through the system and design a pilot project to test the system and verify the procedures.

6. Identify appropriate implementing agency, recommend equipment and operational procedures.

In addition to the above scope-of-work the trip agenda included:

a. Monitoring the development of a food consumption survey which is designed to learn about wheat consumption and whether vitamin A fortified wheat would be used by the target recipients.

b. Review the possibilities for iron fortification of food with emphasis on the mechanics of iron fortification of whole wheat.

c. Review status of program for iodization of salt and study possibilities for the vitamin A fortification of salt using a protected vitamin A preparation.

II. SUMMARY

The comments and recommendations made in this summary are based on the extent of data collection and interpretation that could be accomplished during the visit. Additional information is being gathered by the consulting firm responsible for preparing the feasibility studies and final report. More complete analysis of the data, equipment needs, and determination of feasibility is being carried out by them. This writer will review the content of their draft report when it is prepared.

The present system of receiving, processing and distributing wheat, both domestically produced and imported, is designed to give coverage of the country

and to make wheat available to recipients in special feeding programs as needed. The system appears to perform satisfactorily. From a technical stand point it is feasible to fortify all imported wheat which enters the system from the delivery ships in bulk. Such wheat represents about 50 percent of the total imports or about 900,000 tons. The remainder of the imported wheat is bagged in the hold of ships and barges and does not present a point for fortification intervention.

The present system of four standard silos used by the Ministry of Food for handling imported wheat appear to have sufficient controls on the equipment so that vitamin A fortified wheat could be prepared by controlled blending of premix wheat with regular wheat at each silo. The accuracy of this system for blending premix wheat should be demonstrated, however, before a commitment to a national program is made.

It seems quite untenable to have imported wheat fortified at the port of shipment in the donor countries. This would require duplicate fortification equipment in from 8 to 12 different ports around the world, duplicate stocks of premix wheat in each location, extremely careful coordination of arrival times in Bangladesh to meet program needs and facility capabilities, and other logistical problems.

In order to improve the coverage of fortified wheat in the southwest quarter of the country the pneumatic unloading, storage and bagging facility located at

Khulna could be used in its present form to bag fortified wheat delivered from Chittagong or could be modified with appropriate mixing equipment to allow for the production of fortified wheat at that site. System design and costing for this is being done.

Government response is positive that the special marking of bags for fortified wheat, their separate accountability during distribution and the associated changes in record keeping required to assure availability of fortified wheat to the target recipient could be accomplished with no harmful disruption of the system and no major changes required in the structure of the present system in use.

A series of blending tests should be conducted to demonstrate the ability of the present wheat handling system to adequately prepare vitamin A fortified wheat. It should include the use of marker material initially and premix kernels in a final test. Any necessary modifications should be made and the system retested.

A pilot test should be carried out as the initial phase of a national fortification effort to reach the food distribution program recipients. It should be designed to include every process, storage and distribution component of the system.

The implementing agency for a national fortification program would be the Ministry of Relief and Rehabilitation. They are responsible for the conduct of the programs designed to reach the intended target groups.

In addition to a determination of the feasibility per se of vitamin A fortification of wheat in Bangladesh a preliminary evaluation of the potential impact of wheat fortification was made. Through the Vulnerable Group Feeding program about 1.8 million people, mostly women and children, could be supplied a daily requirement of vitamin A throughout the year. However, based on present operation of the Food for Work program a typical recipient receives wheat for about 21 days per year. The number of recipients reached in this limited way is about 20 million.

A concern is whether the intake of vitamin A for 21 days per year would be beneficial to the recipients. Significant increase in the vitamin A level of fortified wheat could be considered for FFW recipients. Possible benefit of this approach should be compared to possible liabilities such as another commodity for the system, consumption by pregnant women, or delivery to the wrong recipients.

The goal of a national program and the improvement in vitamin A nutriture expected should be carefully compared with the resources and operational changes required to implement it.

Planning was started on a food consumption study to gather information about wheat consumption and use by target recipients. The study also will gather similar information on the use of salt. The study is scheduled to be carried out over the next several months.

The feasibility, cost effectiveness and potential impact for the iron fortification of wheat are the same as those found for the vitamin A fortification of wheat. Premix kernels would be used containing an iron source, preferably ferrous sulfate.

The present system for producing iodized salt in Bangladesh appears suitable for the production of vitamin A fortified salt. At the present time the technology for producing a vitamin A preparation that can withstand the destructive effects of wet salt has not been perfected. When such material is available the vitamin A fortification of salt in Bangladesh should be considered.

The content of this report was discussed in two separate debriefing sessions at the end of the TDY period. The first session was held in the offices of HKI. Attendees were Tony Drexler, Rita Lavell, Ian Hill, M.M. Ali, and Fred Barrett. Fred Barrett presented the report in detail. This was followed by point by

point discussion and peripheral issues related to vitamin A physiology and HKI next steps toward a food fortification program.

The second debriefing took place at USAID and was attended by Alan Hurdus, Lowell Lynch, Mary Lee McIntyre, Tony Drexler and Fred Barrett. Again the report was presented in detail with more emphasis placed on the iron fortification considerations. Detailed discussion followed. USAID has efforts underway to get domestically produced wheat brought with the grain handling system so that it could be fortified with iron and/or vitamin A. There was indication that some funding might be available through a monetization program of Title II goods to help cover any added transportation expenses for relocating fortified wheat between silos and supply points to meet program needs for fortified wheat.

III. BACKGROUND

Vitamin A deficiency has been identified as a serious nutrition problem for the people in Bangladesh. Reports on several recent studies done in Bangladesh have established that as many as 70,000,000 people are affected by vitamin A deficiency with 900,000 children suffering from eye disease and perhaps 30,000 children blinded, each year due to severe vitamin A deficiency (3)(4).

The Bangladesh Programme for the Prevention of Blindness (BPPB) is active in the distribution of vitamin A capsules which reach 8 million children and prevent perhaps 8,000 children from going blind each year. However, compliance does not always reach the poorest and neediest candidates on a regular basis. Helen Keller International (HKI) a U.S.-based private voluntary organization seeks to expand the effort and coverage for availability of vitamin A to reach more people in the at-risk group. One method HKI proposes to use to do this is through a food fortification program for the vitamin A fortification of a selected food or foods.

Crowley (2) carried out a feasibility study for the fortification of food with vitamin A in Bangladesh which reviewed the foods available and consumed by those groups more vulnerable to vitamin A deficiency and identified one as a vehicle for vitamin A fortification. Wheat was identified as being consumed by low income families in significant amounts. It appeared that wheat was under sufficiently controlled conditions through the imported wheat program to be a suitable vehicle to carry vitamin A. The major programs that would be included for the distribution of vitamin A fortified wheat were the Vulnerable Group Feeding and Food for Work.

Crowley recommended feasibility studies on the adaptability of the present wheat processing and distribution system in Bangladesh to fortify and deliver imported wheat for use in special feeding programs and for assessing the potential impact of using vitamin A fortified wheat.

IV. FORTIFICATION OF IMPORTED WHEAT

As part of their continuing development of a food fortification program to help alleviate vitamin A deficiency and its associated maladies, Helen Keller International decided to support feasibility studies to determine the viability of a food fortification program specifically the vitamin A fortification of wheat. Technical assistance was requested to participate in the planning and conduct of engineering and logistic studies to identify any contraints to the fortification of imported wheat in Bangladesh.

The work reported in this paper was carried out to determine the feasibility of making vitamin A fortified wheat available in Bangladesh for use in special programs, to describe how and where fortification could best be accomplished, and to assess the potential impact of fortified wheat.

The scope-of-work followed to accomplish this included:

1. Perform engineering and logistics analysis to determine the feasibility of fortifying imported wheat with vitamin A at the Chittagong silo and ensuring that the fortified wheat would reach recipients in the Food for Work, Vulnerable Group Feeding and other food distribution programs aimed at the lowest income groups in Bangladesh.

2. Identify the best place(s) to fortify imported wheat by considering Chittagong silo, other sites with in the country or at the point of export in donor countries.

3. Identify and analyze alternative locations in the country and describe equipment needs.

4. Study the processing, transportation and distribution of imported wheat from arrival in ships to the point of distribution to recipients in the Food for Work, Vulnerable Group Feeding and other food distribution program that reach the lowest income groups.

5. Determine whether a subsample of wheat could be fortified and directed through the system and design a pilot project to test the system and verify the procedures.

6. Identify appropriate implementing agency, recommend equipment and operational procedures.

A. Feasibility of Wheat Fortification

Helen Keller International placed a contract with Technical Consultants and Associates (Bangladesh) Ltd. (TECON) to be responsible for carrying-out an engineering and logistics study and performing other tasks that are needed to

enable the determination of the feasibility of fortifying imported wheat with vitamin A in Bangladesh. The scope-of-work for that contract essentially duplicates that described above to be done during the TDY. The main purpose for the TDY was to provide technical assistance to TECON for the planning and carrying-out of these tasks especially in regard to wheat processing, fortification technology and overall guidance for evaluation of information.

Mr. M.W. Ali, Director of TECON is serving as the project manager for this contract. He and I spent considerable time together visiting with government and non-government personnel in Dhaka and across the country collecting the necessary data needed for the study, discussing it and evaluating it in the framework for feasibility of fortifying imported wheat. In some cases the data were not instantly available in distributable form so arrangements were made for later receipt of the information.

TECON is responsible for preparing a final report that includes the satisfaction of all components of the scope-of-work. That report is due to HKI by the end of January 1987. A draft of that report is scheduled to be provided to OICD/USDA for review before being finalized and submitted to HKI for completion of the contract.

The principal entities contacted were the Ministry of Relief and Rehabilitation, the Ministry of Food, and the World Food Program. These organizations have the responsibilities associated with the acquiring, processing and distribution of imported wheat for use in the various feeding programs. The programs studied during this TDY and which would be the primary recipients of fortified imported wheat were the Vulnerable Group Feeding (VGF) and the Food for Work (FFW) progams. Meetings were held with personnel of these agencies for the purpose of learning how the system of receipt and distribution of wheat now is operated,

describing how the wheat could be fortified and distributed using the present system, and discussing any contraints that need to be overcome for successful implementation of a wheat fortification program.

It is the responsibility of the Ministry of Relief and Rehabilitation to see that recipients of the various relief programs receive wheat and other commodities that are distributed as part of the programs. The Director General of Relief and Rehabilitation works closely with the Ministry of Food, World Food Program and Upazilla and local leaders to identify recipients, coordinate receipt and distribution of commodities and monitor the program for efficient and effective operation. An expanded discussion of the role of the Ministry of Rehabilitation and a scenario of the pathway for implementing an intervention appears in Section IV, E. No major constraints were identified by the Director General, Relief and Rehabilitation for the proposed inclusion of vitamin A fortified wheat into the VGF and FFW programs.

The major burdens associated with the vitamin A fortification of imported wheat and its use in relief programs would be born by the Ministry of Food. It is their responsibility to meet the food need of the country. The present system for receipt of imported wheat, bagging, and distribution across the country to central supply depots (CSD) and local supply depots (LSD) was closely studied. The steps of grain unloading, cleaning, bagging, bulk intermediate shipping and distribution through the depots were analyzed for methods of operation. It was found that a fairly efficient and effective system is in place and being adequately operated.

Discussions were held with personnel at each step about what changes would be needed in order to fortify the imported wheat, bag it, mark it with special designation and distribute it through the system. In regards to the actual

addition of vitamin A to the wheat, each of the four silos in operation across the country, Chittagong, Narayanganj, Ashuganj and Santahar appears to be capable of doing this at this time. Performance tests should be conducted at one silo to verify this. This is discussed in more detail in Section IV, C.

The bagging and identification of fortified wheat does not present any problems of concern. Bags are used one time only so there is no problem with chance for mis-identification during a refill program. Record keeping forms and accountability procedures would need to be modified slightly to reflect the presence of fortified wheat in the system and help assure its availability across the country to the intended recipients. Regular wheat now is distributed as bagged wheat in trucks. Bagged fortified wheat could be distributed as part of a mixed load if necessary replacing that amount of regular wheat previously used in the VGF and FFW programs at each location. Distribution center records reflect the number of recipients and the amount of wheat needed for each program per month, year, etc., so the required amount of fortified wheat could be directed to the centers in advance of need in an orderly process.

World Food Program (WFP) is the coordinator of the imported wheat from various donors around the world as well as the portion received from the Government of Bangladesh. WFP personnel expressed concern about introducing another commodity into the system for record keeping purposes as well as concern over the dual possibility either of fortified wheat being in short supply or of it being distributed in place of regular wheat in the event of an imbalance in supply depot stocks. They suggested that fortification of all imported wheat would help eliminate some of these potential problems. Unfortunately a significant amount of the imported wheat is bagged by hand in the hold of mother ships and smaller vessals during the unloading process. This procedure does not present an intervention point for the addition of vitamin A to that wheat. In addition,

more than 50% of the imported wheat used in the Public Food Grain Distribution System is used for programs other than VGF, FFW, and Relief whose recipients are not the poorest of the poor or most nutritionally needy or vitamin A deficient.

Sufficient imported wheat to meet the needs of the FFW, VGF, and Relief programs does enter the Director General-Food silo handling system and becomes available to be fortified with vitamin A. Fortification appears to be able to be accomplished in the present silo facilities and also could be done at the bagging facility on the grounds of the Khulna CSD after modest modification.

Preliminary evaluation of the information gathered from the engineering and logistics analysis indicates that it is feasible to fortify imported wheat with vitamin A in Bangladesh and that it could be adequately distributed to the intended recipients in selected relief programs such as the VGF and FFW.

B. Method of Fortifying Whole Kernel Wheat with Vitamin A

The determination of feasibility expressed above is based on a variety of factors including method of fortification, location of fortification processing and adequate distribution of fortified wheat. This section is the first in a series describing in more detail the information gathered in the engineering and logistics analysis.

The fortification technology to be used to fortify the imported whole kernel wheat involves the preparation and use of "premix" wheat kernels. Premix wheat kernels are prepared by fastening vitamin A material onto the surface of the kernel with edible, food-grade coating materials that seal the nutrient onto the kernel. The vitamin A level placed onto the premix kernels is high enough so that they needed to be blended with regular wheat at a rate of only 0.50% in order to have the daily consumption of wheat include a desired amount of vitamin A.

This technique has been used for many years to prepare premix rice kernels that contain B-vitamins, iron and vitamin A and more recently wheat kernels that contain only iron. Vitamin A fortified premix wheat kernels are available from the company that makes the premix rice kernels used to enrich rice in the United States.

The premix kernels can be added to regular wheat in a continuous process or in a batch process as appropriate. The four silos operated by DG-Food have bin capacity for storing "premix" wheat, valve and slide controls for regulating the addition ratio of premix to regular wheat, and a pathway of conveyors, elevators, and bins that should produce adequate mixing prior to the bagging process. Although these silo systems appear suitable, tests should be conducted to demonstrate their adequacy. These tests are described in Section IV, D.
A quality control function would be needed to monitor the presence and proper level of addition of vitamin A. DG-Food has laboratory capability to perform a variety of tests. If determination of vitamin A is not presently done it is relatively simple and inexpensive to install the capability to do so. The production of fortified wheat would be monitored to see that the bagged wheat was correctly fortified. Periodic checking of bagged, fortified wheat at the point of distribution to program recipients might be included in a quality control program.

C. Location for the Fortification of Wheat

The question of location or where to fortify whole kernel wheat consisted essentially of two parts. The first was whether it is feasible or practical to carry-out fortification in Bangladesh. The second was whether wheat could/should be fortified at the point of export in the donor countries. Both parts were considered and evaluated.

1. In Bangladesh - The information gathered and facilities observed indicated that it is feasible and practical to fortify wheat with vitamin A in Bangladesh. The grain handling facilities are in-place and appear suitable. The silo at Chittagong could serve as the focal point for in-country fortification. First it would serve as a facility for fortifying wheat to be distributed in the southeast portion of the country. Also, it would continue as the distribution point for wheat going to Narayanganj and Ashuganj. That wheat will be fortified at each of those silos for distribution to the north and east portions of the country. The silo at Santahar would continue to be supplied wheat both from Chittagong and Khulna. Wheat could be fortified at Santahar and distributed to the northwest part of the country.

   There is a bagging facility and two-400 ton steel bins located on the grounds of the Khulna CSD at Khulna. Preliminary information indicates that most of the wheat passing through Chalna port is bagged in the hold of ships and is unavailable for fortification. So, if fortified wheat is to be provided to the southwest part of the country two alternatives to be considered are:

   1. Fortified wheat would be prepared and bagged in Chittagong and shipped by coaster vessal to Chalna/Khulna for distribution in the program; or
   2. The facility at Khulna CSD could be modified to include a holding bin for premix, a feeder, and a blending conveyor for the preparation of fortified wheat at that location just before bagging.

Another way that might be used to get fortified wheat into the southwest region would be to ship fortified wheat from Santahar by rail to Khulna CSD for bagging and distribution.

Information that is being collected and which could shape the alternative chosen relates to the number of program recipients in this section of the country which would determine the amount of fortified wheat needed.

A diagram for the installation of equipment at Khulna which would make it a wheat fortification facility and the cost of accomplishing this is being prepared.

It appears that the production of fortified wheat, bagging and marking, and distribution through the present supply system would not be prohibitively difficult or expensive nor too disruptive to the system.

2. In donor country - The other consideration for location of the production of fortified wheat was at the points of export from the various donor countries. There are 8-9 donors at this time representing at least that many countries and there probably are multiple ports for grain export in each country. This could represent from 8 to 15 different shipping facilities. This presents several problems of major proportion to be considered.

First each facility out-loading whole wheat would have to be equipped to hold, feed, and mix "premix" wheat before or at the time of loading. Second, this would require duplication of equipment and stocks of "premix" wheat at each location. Based on the frequency of use of each facility this approach could represent a fairly expensive and relatively inefficient way to provide fortified wheat to Bangladesh.

In addition to these concerns about the facilities, there could be problems with scheduling and arrival. Very careful coordination would be necessary for placing the orders for shipments of fortified wheat sufficiently in advance. Also, space for unloading at the prescribed port of arrival would be needed.

Timing of ordering and arrival would be crucial to help assure an evenness of supply needed all year or in specific periods depending on the programs.

Fortification for wheat outside of Bangladesh and shipment to the country does not appear practical or sensible under the present system of needs, donors and facilities.

D. Tests to Demonstrate Suitability of Present System

The result from visual examination of the facilities at two silos and from conversations with the engineers and silo operators of DG-Food was that the capability appears to now exist in the system for being able to produce vitamin A fortified wheat using premix wheat kernels. However, it would be desirable to conduct blending tests that would demonstrate the suitability of the equipment for fortification and to run a pilot test using a subsample of fortified wheat to test the adequacy of the process and the system for delivering fortified wheat to intended recipients.

The blending testing could be done in two phases:

1. The first phase would test the capability of the silo system to adequately blend two materials. Initially a marker material could be used rather than using premix wheat kernels. The reasons of availability and cost are obvious. Materials that might be used include: lentils, rice or peas which could be detected easily and counted in the wheat sample. Use of wheat kernels marked with materials that are detectable through fluorescence would not cause the loss of the wheat for regular use. Dyed wheat kernels could be used but would eliminate the use of the blended wheat for human use. After mixing, samples would be taken both before the bagging operation and after bagging to determine quantity and distribution of the marker materials. If proper blending is verified then the testing of phase two would be carried-out.

2. The second phase would involve the use of premix wheat kernels containing vitamin A. The blended (fortified) wheat would be sampled before and after bagging with the quantity and distribution of vitamin A in the fortified wheat determined by vitamin A analysis.

The pilot test using a subsample of fortified wheat to test the distribution system is outlined briefly. However, it probably would be the initial step in a multiple step introduction of a national program for wheat fortification so would be developed in detail as part of the project design for that program.

The pilot test would include the following activities:

1. Prepare fortified wheat in the silo.
2. Bag in specially marked bags designating that it contains fortified wheat.
3. Ship bagged wheat through the distribution system to the CSD and subsequent LSD's in a preselected area. The area would be selected based on the presence of recipients of the VGF and/or Food for Work programs. The ordering system normally used to obtain regular wheat for these programs should be used to establish the request for fortified wheat to be used in those programs in that area.
4. Randomly draw bags of fortified wheat at the LSD just prior to delivery to program recipients.
5. Sample and analyze the bags for level and distribution of vitamin A against that expected.
6. Successful demonstration of the adequacy of this system to deliver vitamin A fortified wheat should be followed by expansion of the fortification process into a country-wide program.

E. Identifying the Implementing Agency

It was indicated in Section IV, A, that the Ministry of Relief and Rehabilitation has the responsibility of assuring that recipients in the relief programs receive the alloted commodities. It was decided that during this TDY a review would be made which would indicate which agency of the Government of Bangladesh would be the implementing agency of a national wheat fortification program.

A definition was assumed that "implementing agency" meant that entity responsible for reaching a goal, in this case distribution of fortified wheat to intended recipients. Under this consideration, the implementing agency would be the Ministry of Relief and Rehabilitation.

A scenario for the development pathway of a food fortification intervention using vitamin A fortified wheat might include:

The Ministry of Health presents the country need for vitamin A and requests/requires the availability of vitamin A fortified wheat in feeding and relief programs.

Ministry of Health requests Ministry of Relief and Rehabilitation to issue fortified wheat in specified programs reaching the poorest of the poor, the most nutritionally needy and vitamin A deficient.

Ministry of Relief and Rehabilitation issues quantity orders to the Ministry of Food for the positioning of fortified wheat into CSD and LSD locations.

Ministry of Food carries out activities of receiving, fortifying and distributing wheat as requested to meet program needs.

The Ministry of Food would use their own laboratory capabilities to support the quality control program.

The Ministry of Relief and Rehabilitation would monitor the wheat quality by periodically drawing samples of fortified wheat from the distribution system. These samples would be analyzed in the laboratories of the Ministries of Health or of Science for the presence and content of vitamin A.

F. Potential Impact

Although not a part of the determination of engineering and logistics feasibility per se, it seemed logical to review the potential impact and attainment of goals that might be achieved through the introduction of a food fortification program.

Distribution of fortified wheat in the VGF program would reach approximately 1.8 million women and children. The fortified wheat would contain a selected level of vitamin A which would provide a normal level of vitamin A each day as the fortified wheat is consumed. Use of the wheat each day for a year could be a significant factor in improving the vitamin A nutriture of the recipients and in eliminating the physiological problems associated with vitamin A deficiency.

The Food for Work program is reported to reach approximately 20 million people including the program participants and their family members. Records indicate that the typical participant works in the program for about a month receiving wheat for about 21 working days during that time. If all of the imported wheat used in the program was fortified then these people would be the beneficiaries of about a months exposure to adequate daily levels of vitamin A. It should be evaluated as to whether this amount of increase in vitamin A intake and the period of time involved would have sufficient impact on vitamin A status.

An alternative that could be considered to increase the yearly overall intake of vitamin A by these recipients would be to provide fortified wheat with super levels of vitamin A. This alternative can introduce problems with logistics and possible concern regarding safety.

In regard to logistics, this alternative would require the production of a second type of fortified wheat and inclusion of another (second) new item into the distribution system for record keeping and physical separation. Yet this

item would be produced and used in the system only part of the year. Depending on what approach was used for fortifying the wheat it could require the preparation and stocking of premix wheat kernels with very high levels of vitamin A. Alternatively the regular premix kernels could be added at a rate about 5 times the normal ratio.

The concern of safety is whether, in the attempt to provide a yearly supply of vitamin A in a short time, it would be wise to provide as much as 25,000 IU of vitamin A per person per day for as much as a month at one time. Perhaps the real concern is not so much the ingestion of this level of vitamin A as described by men, children and non-pregnant women but the possibility of this super fortified wheat being consumed by pregnant women and infants. This latter situation could occur in two ways (1) a mix-up in the preparation and distribution between fortified wheat and super fortified wheat (which should be able to be controlled) and (2) the availability of super fortified wheat in the market place by virtue of its being sold by recipients without adequate marking regarding the high levels of vitamin A (which can not be controlled).

An element of the impact of vitamin A fortified wheat relates to the use of that wheat. A food consumption study of recipient households from the VGF and FFW programs is being conducted to gather details of how wheat is used, how much is consumed each day, by which family members etc. Information available in reports about those programs provides some preliminary insight. The VGF recipients consume essentially all of the wheat they receive. The wheat is ground into atta (meal) by a chukki mill. The atta is used to make chapati or other household dishes. Two chukki mill operations were visited to confirm that the whole kernel of wheat is ground and retained in the atta. There is no separation of the bran which contains the vitamin A from the premix kernels. The vitamin A should be mixed throughout the atta just as the bran is also. Thus

all of the vitamin A material, as fortified wheat, provided to VGF recipients would be consumed by them with their increase in vitamin A intake being as expected.

In the case of the FFW program information shows that the program recipients are allowed to, and often do, sell part of the wheat received (perhaps up to 20 percent). Apparently this wheat appears in the market place as well as being sold directly to the final consumer. This selling of wheat and use outside the recipient family makes it more difficult to determine the expected vitamin A intake of family members and the guaranteeing of minimum daily intakes desired.

Finally, it should be noted that approximately 20 percent of the expected wheat contributions to support the VGF and FFW programs is from the Government of Bangladesh. Since there is no provision for this wheat to be put into the distribution system so it could be fortified, it creates an approximate reduction of 20 percent in beneficiaries from the food fortification programs.

G. Cost Considerations

Based on this feasibility study it appears that there would be no need for processing equipment necessary to establish the ability in Bangladesh for the fortification of wheat using premix kernels. The exception to this could be if it is determine later that it is essential to equip the Khulna bagging facility to prepare fortified wheat. In this event the cost could range between $15-$25,000 for feeder, blender and conveyers.

Costs for the fortification (premix) would vary depending on the number of recipients to be reached and the daily level of vitamin A desired. Crowley's report (2) included estimated costs for various levels of vitamin A and the total cost

for the VGF and FFW programs. They showed a cost between $300,000 - $500,000 per year to fortify the wheat for the VGF program for a daily intake of between 1500 - 2500 IU/day. For the FFW program the costs ranged from $850,000 to $1.5 million.

There would be costs for sustaining a fortification program to support activities such as additional quality control for vitamin A, bag identification, premix inventory and public information programs. Those cost can not be properly estimated now but they would be small and insignificant compared to the cost of the fortificant and the total cost of the program.

H. Summary

The feasibility is good for the vitamin A fortification of imported wheat in Bangladesh. The receipt, processing, transportation and distribution of fortified wheat appears to present no problems of major concern. They could be accomplished without major changes in operations. Changes in the record keeping and accountability associated with the introduction of fortified wheat into the system should be few and minor. Distribution of fortified wheat to recipients country-wide could be made from the four silos in the present grain handling system. Information needs to be gathered from which to determine the necessity of establishing the capability for fortifying wheat at the bagging facility at the Khulna CSD. The cost comparisons need to be made comparing the shipping of fortified wheat from Chittagong for bagging at Khulna to the cost of modifying the bagging facility to produce fortified wheat.

This feasibility is based on a program using one fortified wheat at a prescribed vitamin A level so that the typical recipient would receive about 2,500 IU per day of vitamin A in a 250 gram portion of wheat. Such a wheat consumed every day all year could represent a significant improvement in the vitamin A nutriture of the users.

V. Other Activities

In addition to the activities specifically carried out to study the feasibility of wheat fortification with vitamin A, attention was given to other activities which had a peripheral relationship to increasing the vitamin A content of the diet or explored the possibility of including iron fortification of whole wheat to help combat iron deficiency anemia in the country.

A. Food Consumption Study

HKI had proposals from three firms (two located in Dhaka, one in Calcutta) to carry out a food consumption study among recipients of wheat distributed through the VGF and Food for Work programs. The goal of the study is to gather information about how the wheat is used by the recipients. Specifically data would be collected on quantity of wheat received, whether it is consumed or sold, if consumed how processed for use, what dishes used in, how much consumed per child per day etc. The questionnaires are to be designed to focus on the use of wheat and wheat products (flour, chapatti, gruel etc.) and how much is consumed by different family members. This information is invaluable in determining whether the fortified wheat will reach those most in need of it, what level of vitamin A should be added to wheat in order to contribute a prescribed amount per day and if vitamin A consumed would be an adequate amount and with sufficient regularity.

The three proposals were reviewed and comments made to HKI regarding the apparent adequacy of each proposal to obtain the needed information and reach the intend goal. HKI technical specialist was to meet with one of the local firms to discuss details before reaching a decision on awarding the contract. A decision was imminent at the end of this TDY period.

Because of interest generated over the possibility of fortifying salt with vitamin A (see Section V., C) the consumption survey questionnaire was to be designed to include adequate questions to learn about the amount and method of use of salt in the family diet. Information of this type would be important to have to help determine levels of vitamin A to be added to salt.

B. Iron Fortification of Whole Wheat

Recent studies in Bangladesh (Alan and Goff unpublished data) show a high incidence of nutritional anemia. The anemia is defined as iron deficiency anemia and is attributed to an iron poor diet in Bangladesh as well as lack of adequate bio-availability of the iron that is present. The Office of Population and Health, USAID is interested in addressing this problem by implementing an iron fortification program for increasing the level of bio-available iron in the daily diet.

The same considerations for an iron fortification program apply as those for a program of food fortification with vitamin A. Since the vehicle, wheat, has already been identified and is to be the subject of independent feasibility studies attention was given to examining the mechanics of iron fortification of whole wheat along with that carried-out for vitamin A fortification.

The feasibility, cost-effectiveness and potential impact of the processing, transportation and distribution found for the vitamin A fortification of imported wheat also apply to the iron fortification of that wheat.

Briefly summarized they include:

1. A whole kernel premix could be prepared containing both iron and vitamin A. The iron source could be ferrous sulfate or reduced iron for example.

2. The premix kernels could be added to imported wheat at the silos in Bangladesh prior to bagging.

3. The fortified wheat could be transported and delivered to program recipients just as described in Section IV for vitamin A fortification.

4. Levels of iron to be added in the premix would be established by the amount of wheat consumed daily by the target group and the increase in daily iron intake to be obtained.

5. Determination of impact and cost-effectiveness of iron fortification in reducing the nutritional anemia problem would be made based on the actual recipients and the length of consumption of fortified wheat.

Premix kernels of whole wheat have been prepared containing both iron and vitamin A as well as with iron only. These materials are in various stages of testing to determine the storage stability for acceptability and for retention of physiologically active forms of the added nutrients.

Guidance for the development of premix whole wheat kernels has been taken from previous experience with developing premix rice containing these nutrients alone and in combination. Acceptability in cooking tests and informal sensory evaluation has been demonstrated with premix rice kernels and fortified rice.

C. Vitamin A Fortification of Salt

As identified by Crowley (2) in Bangladesh and by many other studies conducted throughout the world, salt is one non-staple food or component of the diet which everyone consumes, in fairly uniform quantities on a regular basis. However,

the common problem and deterrent to the fortification of salt in most countries, especially in developing countries, is the relatively high moisture level and increased content of impurities. This moisture level is appreciably higher than that found in more refined salt and is defined as "wet" salt. The presence of this much moisture in salt contributes to marked destruction of added nutrients such as vitamin A, iodine and iron.

Studies carried out at Iowa State University (5) under sponsorship of the Food Technology Branch (FTB) OICD/USDA have shown the harmful effect of "wet" salt with the destruction of vitamin A being severe and rapid. Vitamin A losses were small and acceptable in dry salt.

Additional studies being sponsored and coordinated by FTB are directed toward producing a vitamin A preparation which has been processed to provide it protection against the destructive effects of wet salt. The process involves coating the vitamin A preparation with a protective material. In addition to the protection provided against wet salt, the coating might be formulated to reduce the loss of vitamin A due to exposure to various forms of light which cause significant losses of vitamin A activity (5).

APPENDIX A

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APPENDIX B

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