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United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.1/10
17 November 1969

ORIGINAL: ENGLISH

Joint FAO/IAEA Expert Group Meeting on the
Production of Fish Protein Concentrate

Rabat, Morocco, 9 - 12 December 1969

UTILIZATION OF FPC: AN ANALYSIS [illegible] NATIONAL [illegible] 1/

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ID/WG.44/10 SUMMARY
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SUMMARY

UTILIZATION OF FPC:
AN ANALYSIS TO HELP FRAME NATIONAL PROTEIN STRATEGIES 1/

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A methodology is proposed to provide analytic guidelines to assist Governments in making decisions on nutrition objectives and programs. This analysis permits comparison of FPC with other fortification possibilities and, in addition, illuminates the nutritional implications of national agricultural and related

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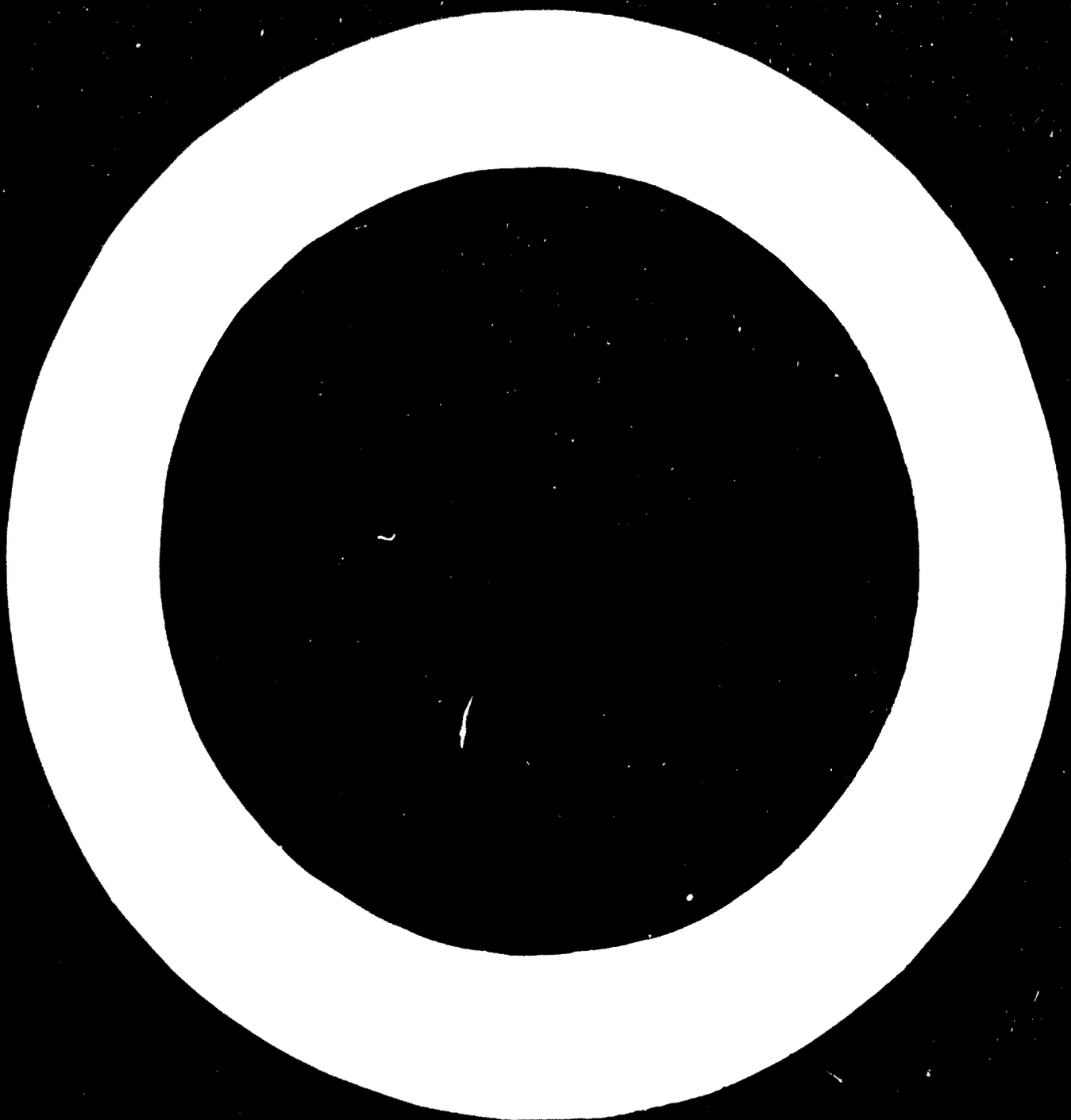
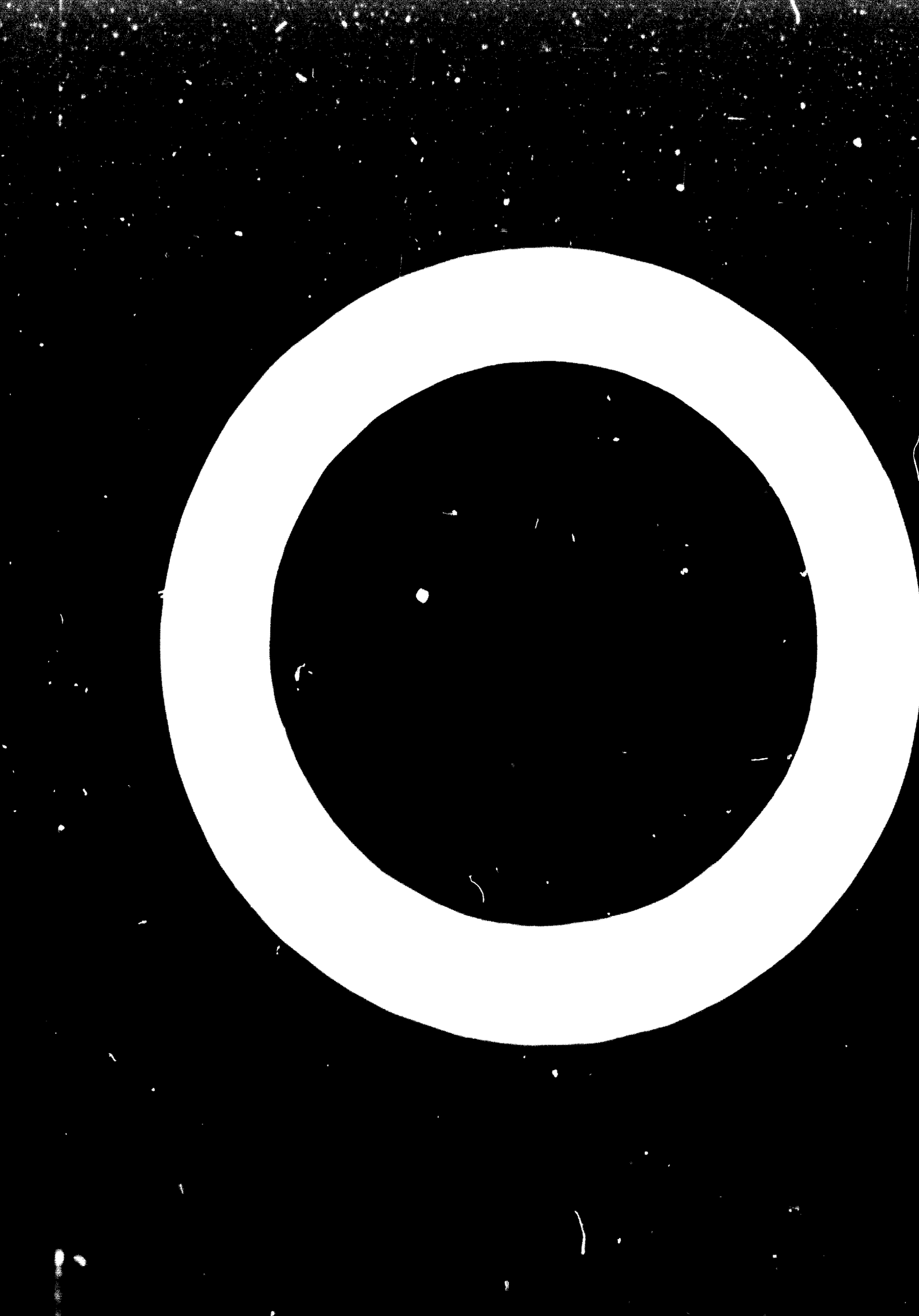


policies affecting public and private investment in one food versus another. The calculations include reference protein price ranking of various foods normalized to the staple of a country and, if desired, can be progressively modified to permit comparisons when other factors are taken into account, such as protein-calorie efficiency, consumer demand, acceptability, and others.

The analysis of the price of reference protein provided by FPC and other fortification materials is made to distinguish between the "incremental" cost of only the additional protein made available by the fortification agent and the integral cost or the cost of all the protein--that normally in the vehicle being fortified and that generated by introducing the fortification agent. This distinction results in FPC being the lowest cost on an integral or total cost basis while L-lysine is the lowest cost on an incremental cost basis. This distinction is of major importance to governments which may have to decide whether to import fortified wheat flour (where the total cost is critical) or whether to fortify its domestic wheat supply (where the incremental cost is critical).

The absence of specific national nutrition objectives in most countries is matched by the general lack of attention to the nutritional effects of existing agricultural policies, subsidies, and programs. Countries will inevitably have to formulate nutrition objectives and face the possible painful adjustment in existing policies and practices. In most countries, the competing claims for land and the fish protein potential are forcing intensified attention to the seas as sources of protein. Questions are already arising as to the investment emphasis given to the fish industry

as compared with poultry and other protein sources. The probable slow rate of increase in the income of the poorest groups of the population will force concentration of new FPC and other fortification programs based on staple cereals now consumed by such groups. Governments will need to harmonize nutrition objectives with balance of payments policies, resource development policies, and investment incentives. Particularly with regard to FPC, the uneven distribution of fish resources in the world could generate an international trade in FPC somewhat similar to that in non-fat dried skim milk.



UTILIZATION OF FPC:

AN ANALYSIS TO HELP FRAME NATIONAL PROTEIN STRATEGIES

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Comparative Costs of Reference Protein

There are few analytic guidelines available to assist governments in making decisions on nutrition objectives and programs. Analysis is needed not only of Fish Protein Concentrate (FPC) and other staple fortification possibilities but also of the nutrition implications of national agricultural and other policies affecting investment in one food versus another. For this reason, the authors have used a model[1] incorporating price, reference protein[2] and other relationships in a hypothetical developing country which displays a protein gap. This model considers important traditional foods as well as for illustrative fortification packages. In this paper, calculations are

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(1) Developed by S. M. Cantor Associates

(2) A protein having an essential amino acid pattern and total essential amino acid content corresponding to the modified [illegible] reference pattern as given in "Protein Requirements, Report of a Joint FAO/WHO Expert Group," [illegible] Series No. [illegible], 1965. pp. [illegible] tryptophan and sulfur amino acid values are lower than the [illegible] provisional pattern by the amounts proposed in the text of Rept. No. 301, pages 33 and 34

used to show protein price rankings[3] of various foods and fortification packages relative to a staple--in this case, rice. By taking additional factors into account, these rankings can be progressively modified and extended to permit other comparisons such as consumer demand and acceptability, protein-calorie efficiency, and investment attractiveness.

The calculations attempt to answer the question of what would be the best product to invest in if a government or a private investor, or both, were interested in a product (1) which could provide to low income groups the highest possible yield of reference protein; (2) whose price per unit of reference protein was low relative to a staple cereal--in this case, rice; and (3) which was in strong demand by low income consumers and likely to become increasingly in demand as incomes increase.

The significance of the model is methodological. The calculations provide the effects of a particular set of price relationships at one point in time. As these price relationships change, the calculations may yield quite different results. The sensitivity of the calculations was illustrated by testing them with the results of an analysis of soybean product consumption by the consumers of the sample country. Most of the consumption of soybean products in that country is not in the form of soybeans, but in the form of bean curd and the price of bean curd is significantly higher than all other soybean products consumed by humans. If the adjustment in price is made

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(3) The major food commodities of a country ranked in relation to an appropriate standard (rice, in the case of rice-eating countries) according to the cost of a kilogram of reference protein as furnished by each food commodity, assuming it is purchased only for its protein value.

to reflect the price of bean curd, then the soybean approach becomes less attractive than fortification by either soy concentrate or FPC.

The calculations do not respond to the private investor's need to know in highly specific terms the details of specific projects--capital requirements, costs of production, potential sales, potential profits, financial terms, potential return on capital, and other critical variables. Nor does the analysis at this stage answer questions which government planners need to know in connection with issues of the allocation of government resources or the encouragement or discouragement of the allocation of private resources. However, the calculations can be extended to estimate what the balance of payments effects will be if particular commodities or fortification packages are pursued, or the employment effects, or the costs to the economy of adopting one means of achieving nutrition objectives rather than another. Keeping in mind the progressive increase in the number of assumptions underlying the values used in the calculations, extensions of this kind tend to become increasingly less reliable. Nevertheless, they constitute a beginning to systematic analysis.

For the purposes of this study, we have directed most of our attention to the price per kilogram of reference protein as a basis for comparison. A summary of this information is given in Table I. In this table, "relative reference protein price ranking" is defined as the price of the reference protein in rice divided by the price of the reference protein in the particular foodstuffs (i.e., inverse normalization).

TABLE I

Price Relationships for Reference Protein of Traditional Foods

	U.S. Price per Kilogram of Reference Protein (in U.S. dollars)	Relative Reference Protein Price Ranking (rice = 1.00)
Cereals		
1. Rice	$4.26	1.00
2. Barley-H	2.61	1.62
3. Barley-N	2.30	1.86
4. Wheat	2.78	1.53
5. Other	3.41	1.25
Vegetables		
6. Soybeans	.61	7.05
Soybeans (as beancurd)	1.60	2.66
7. Other pulses	.73	5.80
8. Potatoes-sw	10.19	0.42
9. Potatoes-w	4.78	0.89
10. Other	18.52	0.23
Animal		
11. Beef	2.98	1.43
12. Pork	1.85	2.30
13. Chicken	1.85	2.30
14. Fish-dry	.86	5.00
15. -fresh	.84	5.40
16. -shell	1.89	2.25
17. Milk	9.44	0.45

Comparisons of traditional foods show the superior position of soybeans and pulses among vegetable sources and the distinct advantages offered by fresh and dried fish over other sources of animal protein. The implications of these rankings with respect to economic policy are touched on later in this section.

A similar comparison for fortification packages is set forth below:

TABLE II

Price Relationships for Reference Protein from Fortification Agents

	U.S. Price per Kilogram of Reference Protein from Agent (in U.S. dollars)	Relative Reference Protein Price Ranking (rice = 1.00)
Fortification Packages[1]		
Lysine 0.2% in wheat	.14	31.5
Soy concentrate 6.0% in wheat	.54	7.8
FPC 5.0% in wheat	.36	11.7

(1) Price of lysine, soy concentrate and FPC are U.S. $1.00 per lb., U.S. $0.27 per lb., and U.S. $0.25 per lb. respectively.

It should be noted that the superior position of lysine fortification relative to soy and FPC is based upon the price per unit of only the additional protein made available by the fortification agent. This "incremental cost" approach should be compared with the recent evaluations made by D.M. Hegsted comparing lysine and FPC fortification of wheat flour under specified cost assumptions. His findings, which are summarized in Table III, are based on a "total" or "integral cost" --the cost per unit of the total protein in a unit of fortified wheat flour; i.e., the protein normally in wheat plus the protein made available by the fortification agent.

Effect of Supplementation of Wheat Flour upon the Nutritive Value of Protein and Relative Costs of Utilizable Protein

(From [illegible])

	% Protein Content	% Relative Nutritive Value[a]	% Utilizable Protein[b]	Cost, $/cwt[c]	Cost of Utilizable Protein, $/lb.
Wheat flour	13.[illegible][d]	[illegible]	[illegible]	[illegible]	[illegible]
Wheat flour + 0.2% lysine·HCl	13.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wheat flour + 0.4% lysine·HCl	14.29	[illegible]	6.[illegible]	[illegible]	[illegible]
Wheat flour + 0.4% lysine·HCl + 0.[illegible]% threonine	14.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wheat flour + [illegible]% FPC	16.66	[illegible]	[illegible]	[illegible]	[illegible]
Wheat flour + 10% FPC	21.76	[illegible]	[illegible]	[illegible]	[illegible]

FPC = fish protein concentrate

[a] Nutritive value relative to lactalbumin

[b] Protein content x RNV (relative nutritive value) = utilizable protein.

[c] [illegible] $[illegible]/cwt [illegible] from rats [illegible] Samuel [illegible]. [illegible] costs [illegible] and FPC [illegible] $[illegible], $[illegible] and $[illegible]/lb. [illegible]

[d] N x [illegible] (all assays are based on nitrogen [illegible]).

[redacted]

[redacted]

[redacted]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Thus, the cost of adding one kilogram of reference protein to the diet is $0.13, using L-lysine at the 0.2% level versus $0.[illegible] using FPC at the 5% level. If, however, the cost per unit of total protein is used, FPC appears superior to lysine with the cost of total protein using FPC at $1.21 and $1.35 using lysine. The difference would be more pronounced at higher levels of FPC. As noted later in this report, the planner would be particularly concerned with the cost of obtaining new protein resources. In this regard, he will regard the protein from the existing wheat crop as a protein resource already available and will be interested in comparing the new protein costs connected with alternative fortification agents. If the planner wished to develop the maximum amount of additional protein by encouraging new wheat production and the fortification of this wheat then the total protein cost of the package would be critical. In this case, an FPC/wheat package, as the suggested analysis shows, would provide this new protein at the lowest cost.

Cost effectiveness Considerations

The comparison of total and incremental costs in light of a stipulated national nutrition objective lays a basis for some preliminary cost-effectiveness analysis. Where the stipulated objective includes the condition of avoiding substantial foreign exchange expenditures, commercial imports of wheat may be rejected regardless of how low the international price may be. Where the stipulated objectives emphasize as the target group infants and young children, the limited capacity of such children to consume the large amounts of cereals which would be required in lysine

package to obtain a satisfactory amount of protein would make a protein augmentation strategy such as FPC far more attractive in a cost-effectiveness sense. But this objective itself raises a new kind of problem relating to formulating new products for child feeding.

An additional and critical element to be weighed is the "delivered cost" of protein. Again the analysis depends upon the nutrition objective formulated by the government. A generalized objective to get more protein to low income families at the lowest delivered cost might suggest lysine fortification of noodles and other wheat products distributed commercially. Limiting the target groups to children might lead to a highly specific child feeding program utilizing FPC as a milk toner or FPC plus cereals and amino acids in special food formulations distributed through maternal and child health centers. In this option, the delivered cost per head might be much higher than a general fortification program but the total cost might be much lower. Moreover, if the policy aimed also at increasing the survival rate of children as a necessary precondition for accelerated family planning, the benefits of child feeding programs would be enhanced.

Cost of Closing the Protein Gap

A reference protein deficit of 31,000 tons was estimated for the sample country used in this report. It will be noted in the table following that the costs of filling this deficit with conventional protein sources range from a high of U.S. $140 million for rice to a low of U.S. $27.6 million for fresh fish. The fortification agents are in themselves lower in cost but in each case a substantial increase in the domestic wheat supply is needed in order to obtain the required protein through fortification.

TABLE IV

Cost of Providing 31,000 Tons of Reference Protein by Increasing the Supply of Selected Commodities

	Cost (U.S. $ millions)	Percent increase over present supply needed to fill protein gap
Rice	140.7	21
Barley	81.4	35
Wheat	91.8	100
Soybeans (beancurd)	59.2	61
Beef	98.5	108
Pork	61.1	448
Chicken	61.1	464
Fish (fresh and processed)	27.6	11
Lysine 0.2% in wheat	4.4 (plus $10.3 for additional wheat	(10.8% more domestic wheat or equivalent imports
FPC 5.0% in wheat	12.0 (plus $7.4 for additional wheat)	(24% more domestic wheat or equivalent imports

In light of the above, the total cost of closing the protein gap by lysine fortification of the existing plus the newly required wheat supply would substantially exceed the total cost (fortification agent plus new wheat) of an FPC program or of an expansion in domestic fish supplies or of a soy fast fixation program. The additional wheat required for a lysine program would present special problems in the use of scarce agricultural land to avoid displacing other protein sources as well as special foreign exchange problems arising from commercial wheat imports.

[illegible]

[illegible]

[illegible]

of fresh fish for its domestic market if such action diverted energy and attention from the objective of expanding fish exports. Even if such an increase in the domestic supply of fish were obtained without adversely affecting fish exports, it would still be necessary to examine the investment implications of expanding the fish harvesting, storage, processing and delivery systems.

On the other hand, the question will undoubtedly arise as to whether sufficient [illegible] and resources are being devoted to improving domestic supplies of fish relative to the attention and resources now devoted, for example, to the development of a poultry industry. The nutritional [illegible] and benefits from fish and poultry raise [illegible] questions as to the relative emphasis given to each industry.

The Role of [illegible] Planning

[illegible] of fresh and dried fish in [illegible]

A second question is fortification of [illegible] [illegible] the [illegible] [illegible] fortification [illegible] [illegible]. All of these foods, as well as [illegible]

food preparations, will cost more if they are fortified and the government will face the issue of wheather to subsidize the food processors in order to assure maximum utilization of the fortified foods by low income groups. The government will also have to examine whether free distribution through existing maternal and child health centers would be a more efficient delivery system in terms of reaching target groups than a generalized commercial foods fortification program.

The fortification costs based on domestically-produced FPC are likely to be quite high relative to the importation of FPC from a country such as China which enjoys abundant supplies of cheap raw material. Paragraph (1), an additional form of reference protein and given the centralized government referred to earlier in this paper, would favor importation of FPC. Commercial feeding programs for animals, however, would entail lower annual [illegible] but would generate increased domestic expenditures [illegible] effective enough funding system which would reach the target group.

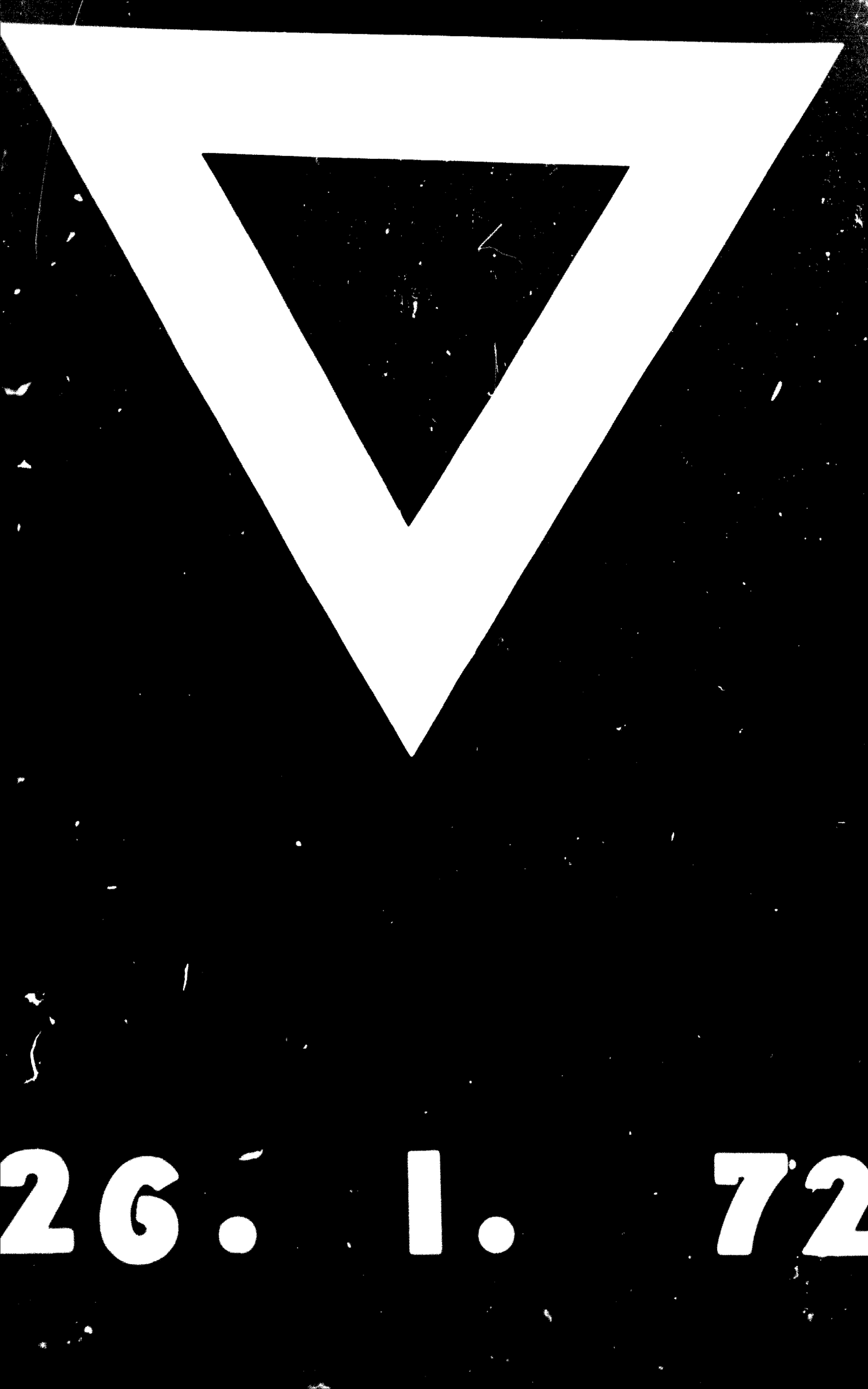
It is highly doubtful that private investors would find an FPC enterprise attractive under current conditions in the [illegible]. Although there is considerable interest among [illegible] manufacturers to fortify their products with FPC, the price at which they would find FPC attractive is far lower than would be given under current prices for raw fish in that country. Some kind of government subsidy and guaranteed purchase [illegible] would be required in order to interest private groups in an FPC manufacturing venture.

The entry of a government subsidized FPC plant into the market for domestic fish supplies in order to produce protein for low income groups would in effect redistribute the country's protein supply to the benefit of consumers. Those people who currently afford much of its highly [illegible] protein

in noodles and other wheat-based foods. The entry of another buyer into the market will tend to increase the price of fresh fish adversely affecting middle-income groups. Unless FPC can be produced without adversely affecting the supply of fresh fish already available in diets, the possible "nutrition improvement" justification for government subsidy disappears.

ACKNOWLEDGMENT

The basic information used in this paper was developed under United States Agency for International Development Contract No. A.I.D./csd-2158 The authors also wish to thank Messrs. George K. Parman, J. B. Cordaro, and Jack M. Adelman of A.I.D. for both their assistance and encouragement.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