Adoption and impact of high quality bambara flour (HQBF) technology in the Northern Region of Ghana

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ABSTRACT

The study focused on the level of adoption of high quality bambara flour (HQBF) processing technology and its impact on end-users. A random sample of 100 women, mainly bambara processors, was selected from Gushiegu/Karaga, Tolon Kumbungu, Savelugu-Nanton, and Tamale districts of the Northern Region of Ghana for interview in June 2004. The Statistical Package for Social Scientist (SPSS), Excel and Econometric Views were used to analyse general data, and the Logit model used to investigate the determinants of adoption. The findings established an effective utilisation level of HQBF at 68 per cent. Variables hypothesized to influence adoption of the improved processing technology from the respondents' own assessments included time of awareness, consumer acceptability/quality of products, credit, availability of raw materials, and sunshine. However, the first two were statistically significant using the Logit model. The technology had had economic impact on 28 per cent of the processors interviewed as a result of 12.5 per cent increase in demand for bambara-based products.

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Introduction

In 1999, a collaborative research project on the production, storage, processing, utilization, and marketing of bambara groundnuts in Ghana was started by the CSIR-Food Research Institute of Ghana with the Natural Resources Institute in UK. The project, which was sponsored by the Department for International Development's (DFID) Crop Post Harvest Research Programme (CPHP) with the CSIR-Food Research Institute of Ghana as the lead institution, aimed at developing effective promotion strategies to improve food security of poor households by increasing availability and improving quality of cereals and pulse foods, and enabling better access to food in the long term. The main objectives were to identify traditional methods of processing bambara in Ghana and to adapt these methods, or if necessary, to develop alternative technology, só that the bambara

cooking process is improved; and to conduct studies to determine the market potential of bambara in Africa and elsewhere to identify opportunities that could facilitate an increase in production.

Bambara is traditionally processed mainly in the northern sector of the country to produce bambara flour and paste that are used in preparing traditional dishes such as "akla" or "koose" and "tubani". The method used in preparing the traditional bambara flour is simple (involving just cleaning or sorting and milling), and is unable to remove the sensory and anti-nutritional factors that constitute a major constraint to its utilization base. Under the project, an appropriate technique for producing an acceptable, high quality bambara flour (HQBF) was developed. The HQBF is a shelf-stable high quality intermediate product for diversified food uses of bambara, intended to enhance the nutritional status of farm families, reduce hunger, and alleviate poverty through increased production of bambara.

After successfully completing the project in 2001, the HQBF technology transfer research project was started in 2002. The project broadly aimed at establishing a value-added chain through HQBF-based recipe development, training of small-scale processors, and involvement of commercial processors as well as sale of well-packaged HQBF through identified market outlets. Under the training and community-based demonstration activity, 10 on-site demonstrations on HQBF technology were conducted for over 300 participants, mostly women, and 219 small-scale women processors in targeted districts including Gushiegu/Karaga, Tolon /Kumbungu, Savelugu/Nanton, and Tamale districts of the Northern Region of Ghana.

The studies investigated adoption and impact of the HQBF technology transfer on the targeted beneficiaries. The survey specifically established the level of adoption of HQBF technology, examined the intensity of adoption, tracked the benefits of the improved technology, and examined determinants for effective adoption.

Materials and methods

Sampling procedure, data collection, and survey areas

Primary data were collected using a structured questionnaire. The structured questionnaire modules consisted of coded questions covering information on socio-economic profile, awareness of the HQBF technology, incidence or level of adoption, intensity or scale of adoption, and modifications. Impact of adoption, determinants for effective adoption, and impediments to adoption of HQBF technology were other issues covered in the questionnaire. A sample of 100 women, mainly processors, was selected from the project districts, using random sampling design. The sample size was highly representative, taking cognizance of the total number of processors trained in a particular area. The survey was applied in selected project districts where there had been previous demonstrations and group training on HQBF technology. These included Gushiegu/Karaga, Tolon/Kumbungu, Savelugu/Nanton and Tamale districts, all in the Northern Region of Ghana. Table 1 presents the various towns covered and the number of people interviewed during the survey.

Operational definition of HQBF technology adoption and data analysis

Numerous theories have been advanced by social scientists and other disciplines to explain and measure technology or innovation adoption (Feder, Just & Zilberman, 1982; Rogers, 1995; Doss, 2003). Most of the reports (Dimara & Skuras, 2003; Karanja, Renkow & Crawford, 2003) on adoption of innovations and improved technologies deal with the long-term rate of adoption, usually represented by an S-shaped cumulative frequency curve, and the factors that influence the adoption decisions. Usually, a distinction is established between the degree of use (intensity of adoption) and incidence or level of adoption of an improved technology.

For this study, the intensity of adoption referred to the extent of use of a technology or

TABLE 1

Towns Visited and Number of People Interviewed

District	*Town*	*Frequency*	*Valid percent*
Tamale	Tamale-Changri	5	5.2
-do-	Nyanshegu	11	11.2
-do-	Dohinayili	10	10.2
-do-	Kumbuyilli	3	3.1
Savelugu	Molaa	3	3.1
-do-	Daire	6	6.2
-do-	Tampiong	6	6.2
Tolon Kumbugu	Kumbugu	5	5.2
-do-	Nyankpala	4	4.1
-do-	Zangbalung	5	5.2
Gushiegu Karaga	Karaga	8	8.2
-do-	Zinindo	5	5.2
-do-	Gushiegu	9	9.3
-do-	Gaa	5	5.2
-do-	Kpatinga	12	12.4
Total	-	97	100.0

Source: Author's compilation

innovation by the adoption unit, once the decision to adopt has been made; while the incidence or level of adoption referred to the situation in which the adopting unit had used or not used the technology or innovation during a reference period. The former situation then becomes a continuous measure, while the latter is a discrete state with binary variables (a processor is either an adopter or is not). The Logit regression model was adopted in assessing factors influencing the incidence and intensity of adopting HQBF technology. Statistical Package for Social Scientists (SPSS) Version 10, Excel, and Econometric Views were used to analyse the data.

The Logit model

Following Pindyck & Rubinfeld (1981), the Logit model is simplified as:

$Ln\{P_i / 1\text{-}P_i\} = \beta_o + \beta_1 X_1 + \ldots\ldots \beta_7 X_7$

where P_i is a probability of being an HQBF adopter for the i^{th} respondent or processor, and ranges from 0 to 1(the qualitative variable adopt is 1 if the processor adopts the HQBF technology, and 0 if he or she does not adopt);

β_o is the intercept;

β_i are the slope parameters in the Logit model; and

X_i is explanatory/independent variable affecting adoption of HQBF technology.

Results and discussion

Socio-economic background of respondents

Bambara was processed exclusively by women. For the survey respondents, most were middle-aged (average of 43 years) married women with an average of six children and had no formal education. Bambara processing was the main source of income for most (68 %). Other primary income-generating activities engaged in were farming, trading, sheabutter processing, and traditional birth attendance. Table 2 presents a summary of the socio-economic profile of the processors interviewed.

Level and scale of utilization

Level of utilization of HQBF technology at the time of the survey (June 2000) was encouraging. Sixty-eight per cent of the sample interviewed were using the technology regularly (Fig.1). The study also showed that only 28 per cent of those

TABLE 2

Socio-economic Profile of Respondents

Socio-economic characteristic	*District visited & % response*				
	Tamale	*Savelugu*	*Tolon Kumbugu*	*Gushiegu Karaga*	*Overall*
Age					
20-30	10.7	20.0	42.7	8.1	16.0
31-40	35.7	20.0	28.6	35.1	31.8
41-50	14.3	33.3	7.2	46.0	28.8
51-60	32.2	20.0	21.5	10.8	20.2
Above 60	7.1	6.7	-	-	3.2
Total	100.0	100.0	100.0	100.0	100.0
Position in household					
Wife	85.7	93.3	92.9	97.4	7.3
Head	14.3	6.7	7.1	2.6	92.7
Total	100.0	100.0	100.0	100.0	100.0
Marital status					
Married	86.2	96.6	92.9	100.0	92.8
Widowed	13.8	6.7	7.1	-	6.2
Divorced	-	6.7	-	-	1.0
Total	100.0	100.0	100.0	100.0	100.0
Level of education					
No Formal Education	89.7	100.0	100.0	100.0	96.9
Primary Level	10.3	-	-	-	3.1
Total	100.0	100.0	100.0	100.0	100.0
Main occupation					
Bambara processing	65.5	66.6	92.9	61.5	68.0
Farming	-	26.7	-	23.1	13.4
Trading	27.6	-	7.1	-	9.3
Sheabutter processing	-	6.7	-	15.4	7.2
Traditional birth attendance	6.9	-	-	-	2.1
Total	100.0	100.0	100.0	100.0	100.0
Secondary occupation					
Bambara processing	3.5	-	-	2.5	2.1
Farming	-	13.3	-	38.5	17.5
Trading	31.0	-	57.2	23.1	26.8
Sheanut processing	6.9	26.7	-	15.4	12.4
Rice processing	-	13.3	21.4	2.6	6.2
NA	58.6	46.7	21.4	17.9	35.1
Total	100.0	100.0	100.0	100.0	100.0
No. of children					
1-5	41.2	46.7	71.4	35.9	44.4
6-10	58.8	53.3	28.6	59.0	53.6
Above 10	-	-	-	5.1	2.0
Total	100.0	100.0	100.0	100.0	100.0

using the technology regularly adopted it for commercial purposes. Among survey respondents, over 70 per cent were regular processors who purposely processed bambara into local foods like "Tubani", "Koose", and "Gablee". Household-based processors constituted less than 30 per cent of the sample interviewed. The survey showed that household processors were more likely to adopt the HQBF on a more sustainable basis. Small-scale commercial processors were the least likely adopters because of perceived effect of risk factors associated with technological changes and dependence on natural energy, sunlight, for drying.

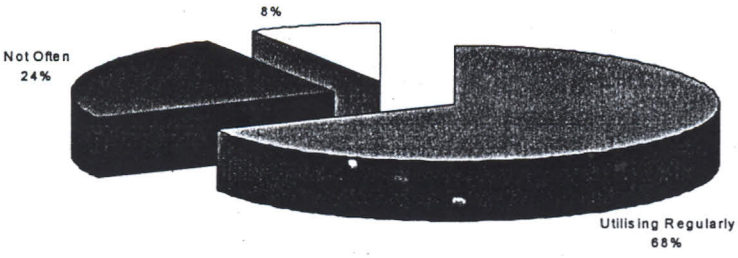

Fig. 1. Level of utilization of HQBF technology.

Among the percentage using the technology (either often or not often), 88 per cent had not modified the original HQBF technology disseminated and, therefore, had adopted a complete technological package; that is, full-scale adoption. Those who had modified the improved technology constituted only 4 per cent of the sample interviewed (Fig. 2). Modifications by some respondents included no soaking to save time, shortening of time of pre-heating to save fuel cost, and addition of yam or cassava flour to further improve the texture of some products ("Tubani", "Koose" and "Gablee"). Fig. 3 presents process-flow diagrams for producing HQBF and its modified versions.

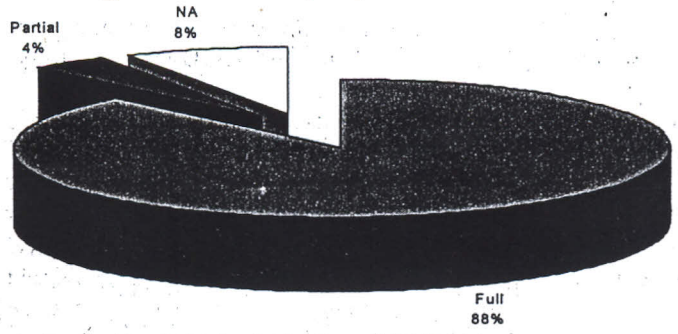

Fig. 2. Scale of adoption of HQBF technology.

Sources of information

The survey showed that among the most important agents for technological change in the agro-processing subsector are the extension agents of Women in Agricultural Development (WIAD) under the Ministry of Food and Agriculture (MOFA). They can assist potential users and make technology transfer operate effectively. Using the trainer-of-trainers' technique, MOFA/WIAD extension agents (AEAs) were trained; and they in turn trained others on production of HQBF in their respective operational areas. Training programmes were organized for processing groups. There were on-site demonstrations at the village level, and one-on-one consultations among processors after training sessions. Fig. 4 presents the various sources of information and knowledge about HQBF technology among respondents.

Most (86%) respondents indicated WIAD/MOFA as their primary source of information and knowledge about HQBF production; while the rest acquired knowledge on HQBF from friends and relatives, teachers, and group leaders in the communities.

Determinants of adoption of HQBF technology

For a preliminary investigation on determinants of HQBF adoption,

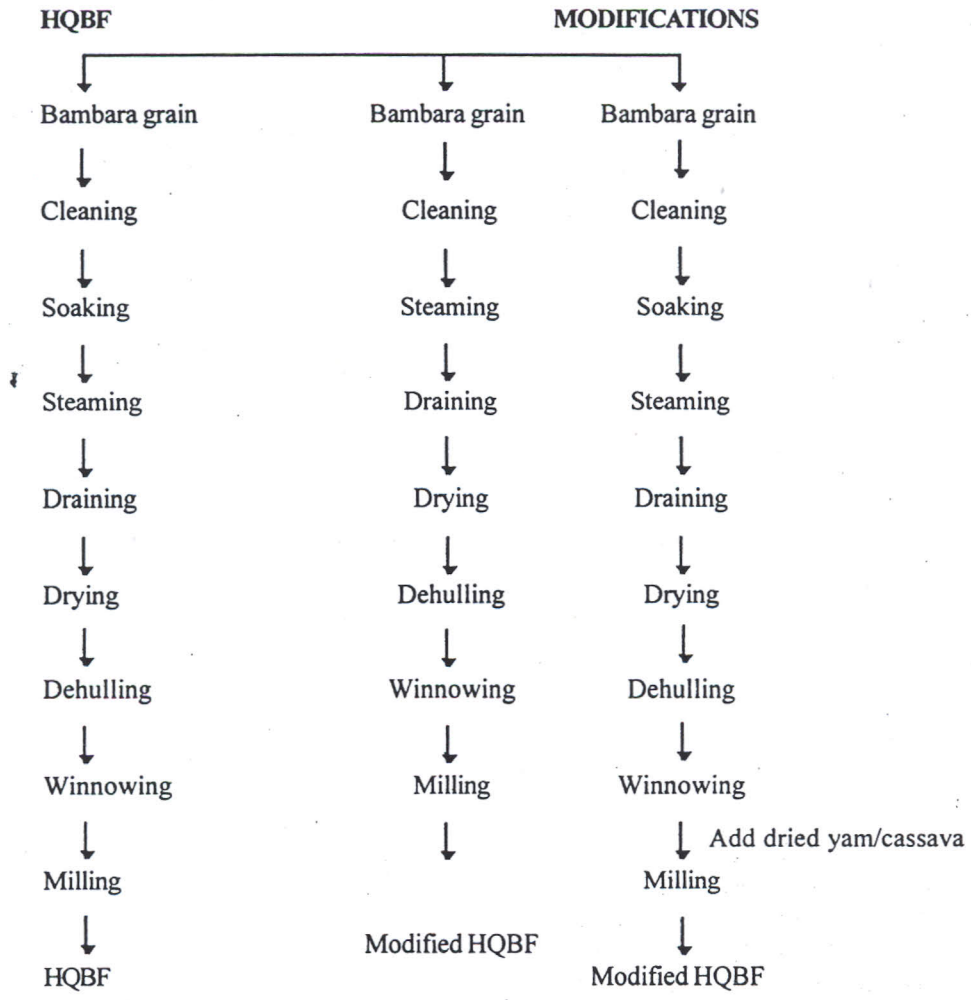

Fig. 3. Flow chart for producing HQBF and the modified HQBF versions.

respondents were asked to express their views on possible factors that affect one's decision to accept/adopt or reject/not adopt an improved technology. Table 3 presents results on proposed factors affecting respondents' decisions on adopting HQBF technology. Again, respondents were asked to rank factors affecting their decisions to settle on important factors to be included in the Logit model. Table 4 shows that availability of sunshine, availability of raw material (bambara), and time of introducing HQBF technology ranked first, second, and third most important factors affecting adoption of HQBF technology, respectively.

Combining results summarized in Tables 3 and 4 (responses derived from the formal survey), variables hypothesized to influence adoption of HQBF, from the respondents' own assessments, were time of awareness, consumer acceptability/ quality, credit, availability of raw materials, and sunshine. Besides the factors enumerated, some socio-economic factors, which had been

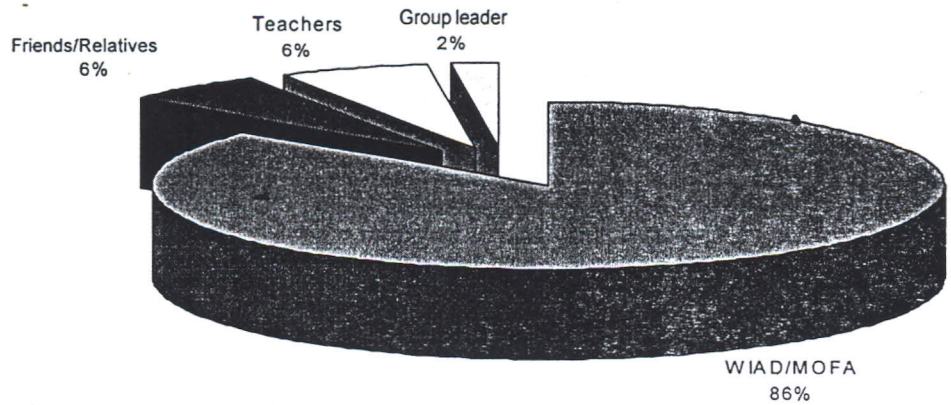

Fig. 4. Sources of information and knowledge about HQBF technology.

proposed to affect decisions on technology adoption (Doss, 2003; Garcia, 2001) and also suggested from the socio-economic profile of respondents, were introduced into the model to check the level of influence on adoption of HQBF technology. Table 5 presents results on variables hypothesized to influence adoption of HQBF technology. Among the variables, only the period of awareness and consumer acceptability turned out to be significant, using the Logit model analysis (Table 5).

Impact of adopted technology

Table 6 presents the baseline levels of key performance indicators, the expected levels, and the achievements at the time of survey. Respondents were asked to express their views on changes in demand, yield, selling price, taste, and labour requirements. Responses on these indicators also formed the basis for calculating changes in some key impact indicators. Table 7 gives summary results of changes in demand, yield, selling price, taste, and labour requirements of HQBF-based products. Improvement in product quality/taste is the most important benefit perceived to be associated with adopting HQBF technology, and probably the key selling point. This confirms the assertion that technology use in the food processing subsector is closely connected with the desire to improve quality (Baldwin, Sabourin & West, 1999; Baldwin & Sabourin, 2002). The taste of all the three key products is greatly enhanced, which influences sales positively and results in more recommended sales. For situations in which market size is fairly constant, products sell faster and processors have more time for other commitments. Other improved qualities of HQBF-based products enumerated by respondents included smooth and soft texture, and better colour/enhanced appearance. Products are also of better quality without stones and other foreign particles.

Heat treatment kills all the weevils and other pests. Estimated increase in demand as a result of adopting HQBF technology was 12.5 per cent. Fig. 5 presents benefits derived from HQBF technology.

Effective utilization level of HQBF was estimated at 68 per cent. Variables hypothesized to influence adoption of HQBF technology, from the respondents' own assessments, included time of awareness, consumer acceptability/quality of products, credit, availability of raw materials, and sunshine. However, statistically, time of awareness and consumer acceptability/quality of HQBF-based products significantly affect adoption decisions. About 28 per cent of the respondents indicated 12.5 per cent increase in demand for HQBF-based products. This translated into processing levels of up to 34 kg/

TABLE 3

Preliminary Investigation into Determinants of HQBF Adoption

Factor	*% response*		
	Yes	*No*	*Remark*
Availability of market	55.1	44.9	Respondents had a mixed reaction to the question of whether availability of market was a determinant of HQBF technology adoption; with close to 45% expressing that for now, the issue of market for processed products might not affect ones decision to adopt the technology, while the rest thought otherwise.
Cost of inputs	51.7	48.3	Similarly, cost of inputs was considered to be an issue by a little over 50% of the respondents, because HQBF production has an element of steaming with additional cost on fuel.
Availability of sunshine	86.5	13.5	Availability of sunshine was a key decision factor of utilization of HQBF technology which requires sunlight for drying after the pre-heating treatment. This they had no control over.
Availability of raw materials	80.9	19.1	Availability of raw material (bambara grain) was another key decision factor of utilization of HQBF technology. Apparently respondents indicated non-availability of credit to do bulk purchases of grains.
Credit	44.3	55.7	Less than 50% of respondents indicated that availability of credit would not affect their decision to adopt or not adopt the HQBF technology initially, though it could influence sustainability issues.
Quality/consumer acceptability	55.2	44.8	Consumer acceptability of HQBF-based products was crucial to over 50% of the respondents interviewed, and an important decision factor of technology adoption.
Time of introduction of technology	80.9	19.1	Time of introduction was very important. It has to be tied to the peak period of bambara supply. (This has also been found to be an important determinant of technology adoption elsewhere; e.g. Kernga, 2003)
External influence	1.1	98.9	Respondents indicated that external influence, e.g. from spouses, plays a minor role in the HQBF technology adoption process.

processor/day as compared to 22 kg/processor/day before the project started. Constraints identified by respondents included difficulty in drying parboiled grains during the rainy season, unavailability of grains, time-consuming new technology, unavailability of mills, and high cost of fuel.

Conclusion

Technology development should be approached as a partnership between local food processors (industry) and researchers to the greatest extent possible. Research that is focused on an identified problem of a particular group will be most readily received and adopted by the group sharing ownership of the project. Directing selected research efforts toward problem-solving will overcome most barriers to getting the results known or used by the processors. Other recommendations concerning effectiveness of

TABLE 4

Ranking of Responses on Factors Affecting HQBF Technology Adoption

Factor	*Ranking (% response)*							
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*
Availability of market	-	18.4	30.6	24.5	22.4	4.1	-	-
Cost of inputs	10.6	23.4	34.0	25.5	6.4	-	-	-
Availability of sunshine	41.0	34.6	11.5	9.0	1.3	1.3	1.3	
Availability of raw materials	37.5	33.3	18.1	8.3	2.8	-	-	-
Credit	37.5	12.5	25.0	10.0	12.5	2.5	-	-
Quality/consumer acceptability	16.3	20.4	12.2	28.6	12.2	10.2	-	-
Time of introduction of technology	16.7	33.3	16.7	16.7	-	16.7	-	
External influence	-	-	-	-	-	-	-	100.0

TABLE 5

Variables or Factors Influencing Level and Intensity of Adoption of HQBF

Technology

Variable	*Coefficient*	*Std error*	*t-statistic*	*Prob.*
Intercept	2.187572	1.542694	1.418020	0.1603
Age	3.16E-05	0.027098	0.001166	0.0104
Number of children (CHILD)	-0.065695	0.145895	-0.450288	0.6538
Consumer acceptability (FACCEPT)	1.550971	0.569998	2.721012	0.0081
Credit (FCREDIT)	-0.073424	0.567533	-0.129374	0.8974
Availability of raw material (FRAW)	-0.658754	0.776188	-0.848704	0.3987
Availability of sunshine (FSUN)	0.698511	0.870990	0.801973	0.4254
Main source of income (MAIN)	0.368610	0.704669	0.523097	0.6024
Log likelihood -43.00301				

technology transfer include implementing more awareness programmes, providing credit facility, and the need to work on production-related issues to increase supply response to expected demand.

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TABLE 6

Base Levels of Performance Indicators Vs Achievement

Indicator	*Current level*	*Expected level*	*Achievement*
Processing technology	Traditional	HQBF	Tentatively, 28% of the respondents indicated 12.5% increase in demand for HQBF-based products. This translates into processing levels of up to 12.5 bowls (about 34 kg)/processor/day.
Socio-economic processing levels	1-10 bowls/ processor/day	Increase in processing level	
Monthly income levels	$15-$51/processor	Earn additional income	Extra income was in the range of $1-$2/week/ processor using conservative figures; translating into monthly income of about $20-$60/ processor.
Number of people earning extra income (use of HQBF)	Not applicable	No estimated target	28% of sample interviewed earn more income. Using the total number of 219 small-scale processors trained by MOFA, estimated number of small-scale processors now earning extra income is about 61. This excludes those who were trained by relatives and friends and other people.

TABLE 7

Summary of Respondents' Views on Some Impact Indicators

Impact indicator	*% responding to change*			
	Decreased	*Same*	*Increased*	*Remark*
Demand	-	6.5	81.5	The rest did not make any comment concerning changes in demand. Although most adopters were using at the household, the general impression was that because of marked improvement in taste of HQBF products, household members enjoyed extra HQBF products. Those who used the technology for commercial purposes experienced 12.5% increase in size of demand.
Yield	3.2	8.6	77.4	10.8% did not comment. Change in yield of HQBF is relative, depending largely on how well flour mixture is beaten.
Selling price	-	46.2	16.1	37.6% did not comment. Significantly, the household users could not make any comment on selling price. Most commercial users had to maintain the selling price, but indirectly reduced the size per unit to effect marginal increase in the relative prices.
Taste	-	-	93.5	Only 6.5% of the sample could not comment on technological effect on taste. Improvement in taste of HQBF was very obvious, with overwhelming proportion of the adopters indicating taste as a motivating factor in the adoption process.
Labour	3.2	60.2	17.2	19.4% did not make any comment. Relatively, there were no significant differences in labour demands, though the improved technology involved additional processing steps.
Expenditure	11.0	49.5	6.6	33% did not make any comment. Most thought that savings in amount of oil used for frying "koose" were stripped off by cost incurred in fuel for pre-treament.
Income	-	11.0	45.1	43.9% did not make any comment.
Profit	-	7.6	48.9	43.5% did not make any comment. Extra profit made was in the range of ¢5,000.00 to ¢10,000.00 per day.

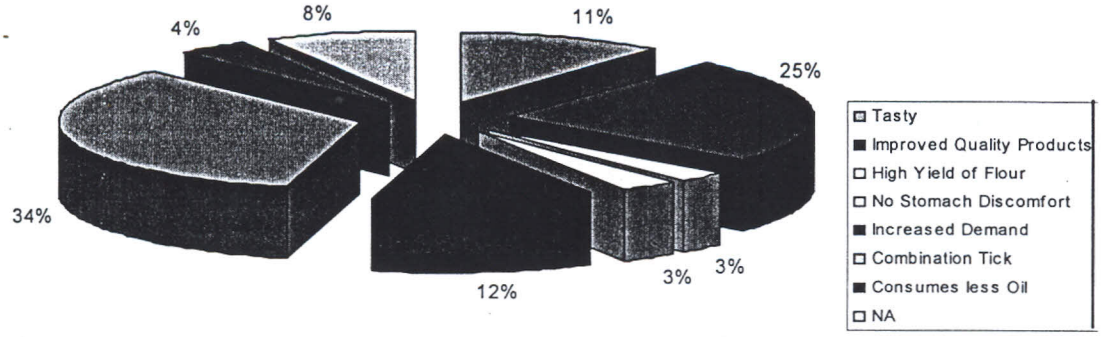

Fig. 5. Percentage distribution of respondents according to most important benefits derived from HQBF technology.

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