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M. D. C. Immink
J. A. Alarcon

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HOUSEHOLD FOOD SECURITY, NUTRITION AND CROP DIVERSIFICATION AMONG SMALLHOLDER FARMERS IN THE HIGHLANDS OF GUATEMALA

by

Maarten D.C. Immink
International Food Policy Research Institute
1776 Massachusetts Avenue, NW
Washington, D.C. 20036

and

Jorge A. Alarcon
Department of Agricultural Economics
P.O. Box 5187
Mississippi State University
Mississippi State, Mississippi 39762

ABSTRACT

The study examined economic, food security and nutrition outcomes associated with crop diversification among small farm households in the Western Highlands of Guatemala. The analysis pulled together data from a farm production and household expenditure survey, and a food intake and anthropometry survey, conducted in the same group of highland farmers but with an interval of eight months. The sample of farmers and their households were classified <u>ex post</u> according to different crop mixes. Compared to traditional maize farmers, small farmers and their households who diversified to potatoes were more likely to suffer adverse income, food security and nutritional status effects; wheat- and vegetable growers and potato farmers with larger farms were likely to encounter increased household incomes. However, no significant improvements in household and individual food security were associated with income increases among diversified farmers and members of their households.

Key words: Crop diversification; smallholder farmers; Guatemala; household income; household food security; nutritional status.

INTRODUCTION

Crop diversification and commercialization among farmers with small landholdings (smallholder farmers) in developing countries has often been signaled as being detrimental to the food security and nutrition of the farmers' households (Lunven, 1982; Fleuret and Fleuret, 1980; Dewey, 1979; Lappe and Collins, 1977, Hernandez, et al., 1974). The basic argument is that commercialized farm households become more dependent for adequate food availability on market conditions, including market prices of farm products, of farm inputs and of basic foods. As cash crops displace food crop production, household consumption of staple foods from own production is thought to be reduced, increasing the household's vulnerability to food insecurity and malnutrition. Labor inputs by household members are often higher in cash than food crops, which may increase the household's dietary energy requirements (Gross and Underwood, 1971). Increased on-farm employment by female members of the household may reduce child care, with detrimental effects on child nutrition (Popkin, 1980). Changes in food intake patterns have been associated with a change towards cash crop production which resulted in a diminished nutritional quality of the diet (Dewey, 1981).

The income and nutritional effects of shifts from subsistence to commercialized crop production may be highly time- and place-specific, as a review of some evaluations of cash cropping schemes has indicated (von Braun and Kennedy, 1986). A series of recent case studies undertaken in Africa (Kenya, The Gambia, Rwanda), Philippines and Guatemala have provided additional results (Bouis and Haddad, 1990; Kennedy, 1989; Kennedy and Cogill, 1987; von Braun, de Haen and Blanken, 1990; von Braun, Puetz and Webb, 1989; von Braun, Hotchkiss and Immink, 1989). The broad findings of these studies indicate that a shift towards commercialized crop production involves significant re-allocation and increased productivity of household resources (particularly land and labor), and is associated with significant increases in household income. Total household availability of food is not negatively affected, and may increase somewhat but the short-term income-calorie intake relationship is generally weak. The effects on preschoolers' nutrition was generally neutral or slightly positive. Economic costs and benefits may be conferred on community members who do not participate in the cash cropping schemes, as both land values and employment opportunities on participating farms increase. The results also stress that the specific economic and nutrition outcomes are likely to be conditioned by the macro-level policy environment related to marketing conditions and prices, rural infra-structure and access to credit, complementary social investment in health and education and technological change focused on food crop production (DeWalt and DeWalt, 1987).

The present study examined economic, food security and nutrition outcomes associated with different crop patterns among smallholder farm households in the Western Highlands of Guatemala. Findings related to household resources allocation effects are only briefly summarized here in order to aid in the interpretation of the income, food security and nutrition outcomes.

METHODS

The study covered a population in the Western Highlands in Guatemala. This area is characterized by smallholder farming systems, low agricultural productivity, and poor access to major markets. The population is predominantly indigenous. Major staple crops are maize and beans, with major cash crops being wheat and potatoes, in some areas. It is an area which particularly suffered from political violence and military repression during the 1980s, and as a result, a large percent of the population has been displaced.

In 1983 the government of Guatemala initiated a program of crop diversification in this region among smallholder farmers. The program is primarily based on cold-weather vegetables, and is financed with foreign loan funds. The aim is to improve the socioeconomic well-being of subsistence farmers and their households, by means of increased household income and on-farm employment. Health and nutrition are to be improved because of the reduced need for seasonal off-farm employment in coastal areas, and increased availability at the household level of a more diversified diet. Cold-weather vegetable production and consumption are promoted by means of credit programs for mini-irrigation systems, soil conservation and farm inputs, and agricultural extension services and food and nutrition education programs.

The study brought together data from two different sources. A farm production and household expenditure survey was conducted by the Ministry of Agriculture, Livestock and Food (MAGA) among 1490 small-holder farmers in February-March 1987 in 12 project and 12 non-project communities. Households were selected at random in each community and included traditional and diversified farm households. Eight months later, the Institute of Nutrition of Central America and Panama (INCAP) conducted a food intake and anthropometric survey among 906 households of the MAGA sample, selected at random (with replacement by randomly selected households when initially selected households were unavailable). The sample selection procedure employed was the single-stage conglomerate method in which communities constituted the conglomerates. The food intake of the household as a whole, and of one preschool child (12-60 months) if present, were measured by means of the 24-hour recall method. The food intake data were converted into daily energy, protein and micronutrient intakes using the Central American food composition table (INCAP, 1971). Anthropometric measurements included: weight, height, mid-upper arm circumference and four skinfolds (biceps, triceps, subscapula and suprailiac), and were obtained in various index household members (when present): preschoolers (12-60 months), school-age children (6-15 years), and one male and one female adult. INCAP also obtained data regarding the participation the previous year by each household in credit and agricultural extension programs.

The households in the INCAP sub-sample were ex post classified into four groups based upon different crop patterns: (a) traditional or "maize farmers" (maize and/or beans production), (b) "potato farmers" (maize and/or beans and potatoes), (c) "wheat farmers" (maize and/or beans and/or potatoes and wheat), and (d) "vegetable growers" (maize and/or beans and/or potatoes and vegetables). The total number of households so classified was 786, which meant that 120 households were excluded from the analysis because they exhibited such a great deal of variety in crop mixes that any further and meaningful classification was not possible.

The study design involved some limitations which should be borne in mind, but which did not prevent us from arriving at important conclusions. The ex post classification of the farmer groups meant that each was not necessarily representative of all farmers with the same crop mix pattern. This limited somewhat the generalization of the conclusions which the multivariate approach as used here could not fully overcome.

Bringing together data from two different periods in the year may have introduced measurement errors, particularly when key variables were subject to seasonal variation. From our knowledge of the study area we assumed that the estimated household incomes in February-March were below average, while estimated total food intakes in October-November were generally above average (though seasonal variation in total energy intakes has been found to be less pronounced than expected in this region). To compensate for any seasonal variation, key variables were categorized in the analysis. This of course rendered less robust conclusions.

A cross-sectional comparison between farmer groups did not deal with the question of inter-temporal stability in crop mix patterns. No data were available to include this aspect as a covariate in the analysis. This concern applies mostly to variables which do not quickly adjust over time to acute conditions (such as children's height, for instance). To our knowledge, diversified farmers in this region were far more likely to adjust relative crop extension shares from one crop cycle to the next (most fluidly between maize and wheat) than to revert completely back to maize production. Our farmer group classification set aside the crop mix stability dimension by not considering the relative share of each crop in total farm production.

FARMER AND HOUSEHOLD CHARACTERISTICS

Forty percent of the (reduced) sub-sample fell in the first farmer category (n=313), 24.2% in the second (n=190), 15.3% in the third (n=120) and 20.7% in the fourth farmer group (n=163). Maize was grown by 97% of the total INCAP sample, beans by 33.4% and potatoes by 37.9%. The principal vegetables grown by the fourth group were: cabbage

(27.0%), carrots (18.4%), cauliflower (14.1%), red beets (12.9%) and broccoli (9.2%).

Diversified farmers tended to have larger farm size than maize farmers (Table I). A selection bias in the adoption of non-staple crops could not be ruled out, and the following analysis attempted to control for this. Heads of wheat-producing households were more often literate and had completed more often some formal education than other farmers. Literacy and achieved formal education by spouses was particularly low among the potato farmers' households. Vegetable-producing households tended to be larger in size. Potato- and vegetable-producing households received more often formal credit and/or agricultural extension services than maize and wheat farmers who may have had to rely more on informal or non-governmental sources of credit. Formal credit and agricultural extension services went most often hand-in-hand, and there was a clear tendency for credit to be granted to farmers with larger landholdings.

HOUSEHOLD RESOURCE ALLOCATION EFFECTS

In the interest of space, we briefly summarized the main findings related to the effects on the allocation of household resources of diversified farmers. The main productive resources of small farm households were land and labor, and crop diversification implied a re-allocation of both. The percent of cropland allocated to maize was reduced with diversification, and remained fairly constant with cropland size among maize-, potato- and wheat-farmers, but fell with cropland size among vegetable producers. Beans were often intercropped with maize, but less so on larger extensions. Among potato and wheat farmers, the percent of cropland allocated to potatoes and wheat, respectively, remained constant with extension size. Vegetables occupied generally a low percent of total cropland (5-12%), which tended to fall with increased cropland extension, except for broccoli.

Vegetables and potatoes were more, and wheat was less labor-intensive than maize. Thus, substitutions of potato and/or vegetable production for maize, created on-farm employment per unit of land, especially as labor-land ratios in maize production tended to increase or remain constant with diversification. On-farm employment for both household and non-household labor was created in maize, wheat and vegetable production among wheat - and vegetable farmers, and in potato and maize (small effect) among potato farmers. The gains in on-farm employment for household labor were relatively greater on farm units with smaller crop extensions. Gains in on-farm employment for hired labor with larger cropland areas were strongest in carrot, potato and beet production, and considerably less in maize, wheat, cauliflower, cabbage and broccoli production.

Off-farm employment by household members tended to be the most frequent among potato farmers, and least frequent among vegetable growers. The male head of household was most often the household member employed in off-farm work, followed by children. Off-farm employment tended to decrease with cropland extension, except among vegetable growers. This pattern was consistent with increased on-farm employment by hired labor on larger farms. Off-farm employment by children tended to increase on larger farms which may be explained by larger household size.

HOUSEHOLD INCOME AND EXPENDITURES

Crop diversification based upon export vegetable production in Guatemala has elsewhere been shown to increase substantially the net returns to land (von Braun, Hotchkiss and Immink 1989). Unpublished data obtained from the National Bank of Agricultural Development for 1986 showed that in the Western Highland regions the gross margins/hectare (adjusted for vegetation period) of different crops were on average a multiple of the gross margins for maize.[1] On these grounds, we expected the maize farmers to have comparatively lower farm incomes, and vegetable growers to have comparatively higher farm incomes, than potato and wheat farmers. On the other hand, potato farmers had more, and vegetable growers less, off-farm employment, which should have reduced the income differentials among the four groups.

Maize and potato farmers on the one hand, and wheat- and vegetable growers on the other, had very similar income distributions in general, with the latter two groups showing higher per capita income levels.[2] Broken down by farmsize class, however, the income differentials among the four groups became more pronounced.

This finding is demonstrated in Table II where the weighted medians of per capita income are presented. Weighted by within-group crop patterns and crop extension class, the overall income differential between maize farmers, and the three other groups were: potato

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[1] Wheat: 160%; beans: 280%; potatoes: 780%; and vegetables: 1,360% (average for broccoli, cauliflower, cabbage, red beets and carrots).

[2] Income was measured as the sum of food- and non-food expenditures and the market value of foods consumed from own production.

farmers: 7.8%, wheat farmers: 23.0% and vegetable growers: 15.6%.[3] Among the farmers with less or equal to half a hectare under cultivation, the respective income differentials were: potato farmers: -9.0%; wheat farmers: 30.3%, and vegetable growers: 19.2%. While among the farmers with more than half a hectare under cultivation, the respective income differentials were: potato farmers: 10.4%; wheat farmers: 15.4%, and vegetable growers: 9.8%. Income gains were only positively associated with cropland extension among maize and potato farmers.

The four groups had generally similar food budget shares, ranging from 42% of total income for the maize farmers to 38% for potato farmers. These percentages appeared to be low for these low income households. It was also apparent that food consumption from own-produced crops by these households constituted a minor component of total income: 3% for maize farmers, 9% for potato farmers, 8% for wheat farmers and 5% for vegetable growers. When these percentages were added to the food budget shares, the total was still less than half the total income in each group.

Crop diversification has often been thought to result in reduced household food supplies from own production due to reductions in area under cultivation in food crops. In order to understand differences in per capita consumption of household- produced crops (Table III), we needed to consider variations in commercialization rates, yields and land allocation to different crops. The main findings related to these factors were only summarized because space limitations prohibited the presentation of detailed data here.

Potato farmers' households consumed slightly less of own-produced maize than maize farmers' households. This difference was more pronounced among farmers with more than half a hectare in crops (26%), reflecting negative differences in percent of land allocated to maize (35%) and in percent of production allocated for household consumption (18%), partially offset by a positive difference in maize yields (19%). Maize farmers' households with larger crop extensions consumed more own-produced maize and beans. These same differences were considerably smaller for potato farmers' households, who consumed significantly more potatoes from own production, particularly when they had larger crop extensions.

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[3] Weighing was done to account for the non-homogeneity within each group in regard to crop mix patterns and cropland extensions. A non-parametric test of unweighted group medians of per capita income indicated a significant difference among the four groups ($X^2 = 12.12$; df = 3; $p < 0.01$), and between maize farmers, and potato farmers ($X^2 = 4.68$; $p \leq 0.05$), wheat farmers ($X^2 = 8.92$; $p < 0.01$) and vegetable growers ($X^2 = 7.16$; $p < 0.01$).

Wheat farmers' households which grew maize consumed overall more maize (18%) than maize farmers, with a significant greater difference (28%) among those with less than 0.5 ha in cropland. Maize yield differences were greatest on larger farms (49%), but wheat farmers with smaller cropland extensions allocated a larger share of their maize crop for household consumption than maize farmers, while the opposite was found among farmers with larger cropland extensions.

Vegetable growers' households consumed considerably less of their maize crop than maize farmers' households. In addition to sharp reductions in the share of cropland allocated for maize production, these households also allocated significantly smaller shares of maize production for household consumption. Only among vegetable growers with larger extensions was there a positive maize yield difference with maize farmers (24%). Vegetable growers who grew potatoes consumed significantly less of their potato crop than potato farmers, despite small yield differences. Consumption of own-produced beans was higher among vegetable-growing households with small farms than among maize farmers in the same cropping extension class. Vegetable growers with small cropland extensions consumed more of their own-produced vegetables (exception: cauliflower) than growers with larger total extensions. Higher yields (exceptions: broccoli and cabbage), larger shares of production allocated for household consumption (exception: carrots) and larger shares of cropland allocated for vegetable production (exception: broccoli) all contributed to the vegetable consumption difference between smaller and larger vegetable growers.

TOTAL FOOD AVAILABILITY

Total household food availability was measured by the daily dietary energy and protein intake levels adjusted for household size and composition (adequacy level). Energy intake levels were compared here to average recommended daily allowances, and not to actual energy expenditure levels. If crop diversification was indeed associated with increased daily energy expenditure levels by household members (as has been suggested elsewhere) through the substitution of on-farm work for off-farm activities, then the comparative analysis here may well have underestimated the energy deficiency status of diversified farm households. We also included the energy and protein intake levels of preschool children (12-60 months). Their daily energy expenditure levels were not likely to be affected significantly by changes in crop patterns.

The households of potato farmers appeared to be the most vulnerable to inadequate daily energy intakes among the four groups (Table IV). The energy intake status of the three remaining groups were quite similar. Daily protein intakes were less of a problem among these households in general, but households of potato farmers were relatively more vulnerable to inadequate protein intakes.[4]

Preschool children were at significantly higher risk of inadequate daily energy and protein intakes, particularly children of potato farmers. In general, preschool children tended to be more vulnerable to food insecurity than the households they belonged to: in three-fourth of those households which as a whole adequately met their recommended daily energy allowances, the preschooler did not. This phenomenon was most often present in potato farmers' households (84%), and tended to decline with farmsize in all four groups, but most notably among households of wheat farmers and vegetable growers.

In order to understand more adequately the factors which increase/decrease the risk of highland households and preschoolers having inadequate dietary energy and protein intakes, two probit models were formulated and estimated. The household model specified as the dependent variable the adequacy of daily energy intake (1=below 90% of recommended daily allowances (RDA)) or of protein intake (1=below 100% of RDA). The independent variables were: per capita income, household size class, consumption of own-produced foods as share of total income, food expenditure share of total income, and farmer group (separate dummy variables for potato-, wheat- and vegetable growers). The results are presented in Table V. On average households with per capita incomes in the middle or upper tercile of the overall distribution were less likely to be energy-deficient by 7%, or protein-deficient by 12% than households in the next lower tercile.[5] This shows that household energy intake levels were generally not very responsive to income changes among these households, in spite of the fact that total food expenditures did respond to income changes (Table II). Households of potato farmers were on average more likely to be energy-deficient than other households by 11%, and more likely to be protein-deficient by 13%. Over and above per capita income levels, the income share of own-produced foods, the food budget share, and household size did not change the risk that households were energy or protein deficient. At the same time, households of wheat or vegetable growers were not less likely to be energy or protein deficient than maize farmers' households.

A different probit model was formulated and estimated for preschool children. The dependent variables were defined the same way as for the household model. The independent variables were: per capita food expenditures, household size class, mother's literacy status,

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[4] It should be borne in mind that the food intake measurements were made at the time when staple foods (maize) were being harvested.

[5] The probit estimates from the models, multiplied by 0.4, become approximate linear probability estimates (Amemiya, 1981).

income share in the form of consumption of own-produced foods, and farmer group (contrasting with maize farmers).

According to results in Table V, for every quetzal increase in monthly per capita food expenditures, the risk that the preschooler's food intake was energy deficient was reduced by 1%. Preschoolers from larger households were less likely to have energy-deficient (by 20%) and protein-deficient (by 16%) daily food intakes. The household size effect may have partially captured an income effect, or may have indicated that in larger rural households, household labor was less restricted allowing more child care, including more adequate feeding of preschool children. Preschool children may also have been more likely (by 12%) to have energy-deficient food intakes when they belonged to potato farmers' households (the probit estimates was only marginally significant).

Of the seven micro-nutrients investigated, calcium and riboflavin were found to be the most limited in the household diets, while iron, vitamin A (as retinol), niacin and vitamin C were limited in a lesser degree, and thiamine intakes were found to be adequate in virtually all households. The results of Scheffe's multiple range test indicated that potato farmers' households had significantly lower vitamin A and significantly higher vitamin C intakes, compared to other households ($p < 0.05$), though in all four groups mean intakes adequately met the recommended daily allowances. Potato farmers' households also tended to have more inadequate mean riboflavin intakes ($p < 0.10$).

Iron, riboflavin and niacin were generally the most limited in the preschoolers' diets. Preschool children of maize farmers tended to have lower mean vitamin C intakes than those of potato farmers, who had lower mean vitamin A intakes than those belonging to other farmer groups ($p < 0.05$). Riboflavin and niacin tended to be the least limited in the diets of preschoolers belonging to wheat farmers' households, while calcium intakes tended to be more limited among children of vegetable growers.

NUTRITIONAL STATUS OF PRESCHOOL CHILDREN

The prevalence of stunting and of weight deficiency among preschool children in the Guatemalan highland regions appears to have increased during the 1980s, pointing to the increased impoverishment of the rural poor. Eighty-three percent of the sample preschool children were found to be stunted (below -2 S.D. of NCHS reference pattern), with over sixty percent severely stunted (below -3 S.D.). Fifty-six percent were found to be weight deficient. These figures were similar to those reported in 1985 for rural preschool children in the central highlands (89% and 42%, respectively) and were higher than those reported in 1983 for the same highland region as covered by the present study (68% and 37%, respectively) (von Braun, Hotchkiss and Immink, 1989).

Among the households within the smallest farm size class, preschool children of potato farmers were most likely, and preschool children of vegetable growers least likely, to be stunted and weight deficient (Table VI). Within the middle farmsize class, potato farmers' children were still at greatest risk of being stunted, but children of maize and wheat farmers were less likely to be stunted than those of vegetable growers. Children of wheat farmers were more likely to be weight deficient than those of maize farmers or vegetable growers. Within the upper farmsize class, children of potato- and maize farmers were about equally likely to be stunted, and those of wheat farmers the least likely. Preschooler weight deficiency was still most likely for those of potato farmers and equally likely for those of wheat farmers and vegetable growers. We found no consistent pattern of a reduction in preschooler stunting with increased farmsize within each farmer group, except among wheat farmers. But a consistent pattern was present with reductions in weight deficiency, again except among wheat farmers.

In order to understand better what factors increase/decrease the risk of preschool children being stunted, we formulated and estimated two probit models.[6] In Model 1 we defined the dependent variable as height/age equal 1 if < - 2 Z's, and in Model 2 as height/age equal 1 if < - 3 Z's ("severely stunted"). The independent variables were: per capita income, mother's literacy status, child's energy and protein intake status, household size class, and household mandays/hectare provided in on-farm crop production. This last variable attempted to measure whether more intensive on-farm employment by household members reduced child care and increased the likelihood of preschoolers being stunted. The results of the probit analysis are presented in Table VII.

The risk of preschoolers being severely stunted (Model 2) was reduced by 7% when the household moved upward to the next higher tercile of the overall per capita income distribution, or by 12% when the mother was literate, while it increased by 12% (marginally significant) when the child belonged to a potato farmer's household. The risk of being stunted was more marginally affected by the variables in Model 1: a risk reduction of 8% when the household jumped upward a tercile of the income distribution, of 14% when the child's protein intake level was adequate, and of 16% when the child belonged to a wheat-producing household. Clearly, large increases in per capita income will be required to reduce substantially the risk of preschoolers being stunted.

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[6] Weight deficiency in children is more likely to be subject to seasonal variation, and the available independent variables did not capture seasonal variation. Thus, no probit models for weight deficiency were attempted.

NUTRITIONAL STATUS OF SCHOOL-AGE CHILDREN

Boys from potato farmers' households were more likely to be stunted, irrespective of farmsize, than boys from other farm households (Table VIII). Among maize farmers in all farmsize classes there was a tendency for girls to be more often stunted than boys, but the opposite tended to be true among children in the other farmer groups (with the exception of wheat farmers in the middle farmsize class). Among boys and girls of vegetable-growing households, there was a clear tendency for a reduced likelihood of being stunted with increased farmsize. A small farmsize effect appeared also to have been present among girls from maize farmers' households.

Weight deficiency was relatively less of a problem than stunting in this cohort of children. Boys from potato farmers' households tended to be relatively at greatest risk of being weight deficient within all three farmsize classes. Girls generally were less likely to be weight deficient than boys. Girls from wheat farmers' households in the lowest farmsize class were more likely to have an adequate weight, while in the remaining farmsize classes this tended to be true for girls from vegetable growers' households. Weight deficiency appeared to be reduced with increased farmsize among girls from maize farmers' and vegetable growers' households. Among boys from wheat-producing households, weight deficiency seemed to increase with increased farmsize. Clearly, there were significant gender, farmsize and crop pattern effects reflected in the physical growth of school-age children, which in turn may have been due to different daily energy requirement levels associated with different crop patterns.

Similar probit models as for preschool children were formulated and tested separately for boys and girls. No food intake data for this age-group were available, thus household energy and protein intake data were substituted. The variable household mandays/cultivated hectare, was included in these models to measure whether more intensive on-farm employment by household members meant raised energy expenditure levels of school-age children which may have increased the risk of being stunted. The results are presented in Table VII.

For boys the risk of being severely stunted was reduced by 26% when the household met its recommended daily protein allowances, and was increased by 22% when the boys belonged to the household of a potato farmer. The risk for boys to be stunted appeared to be less robustly affected by the variables in the model. This was generally true for girls as well. Girls of vegetable-producing households were less likely to be stunted by 17% ($p < 0.10$, Model 1), or less likely to be severely stunted by 19% ($p < 0.10$) when the household adequately met its daily protein allowances.

NUTRITIONAL STATUS OF ADULTS

Three body composition indices were constructed for adults: mid-upper arm muscle circumference, body mass index (BMI = weight/height^2), and percent body fat.[7] The first index served as an indicator of body muscle mass, and the latter two of body energy stores. BMI has been identified as an adequate indicator of chronic energy deficiency in adults (James, Ferro-Luzzi and Waterlow, 1988). Norgan (1990) has recently argued that among poor populations in developing countries, BMI is an indicator of lean body mass as well as of fatness, and that its interpretation as a measure of energy stores may vary in different groups.

Analysis of variance indicated that adult women have significantly larger energy stores when they belonged to households of vegetable growers as compared to maize farmers' households ($p < 0.05$). No significant differences were found among the remaining pairs of groups. Adult males of vegetable-growing households also tended to have a better energy status than maize farmers ($p < 0.05$). This may have reflected a reduction in energy requirements of members of farm households which diversify to vegetable production. Adult women had generally slightly higher mean percent body fat when the cropland extension exceeded half a hectare ($t=2.20$; $p < 0.03$) (the difference in mean BMI was not significant). This was consistent with the finding that a relatively larger share of on-farm labor came from non-household sources when the extension exceeded half a hectare. No significant differences in energy status of adult men with cropland extension class were found. And muscle mass on average in adult men and women did not significantly vary among farmer groups or with cropland extension.

CONCLUSIONS

Diversified farm households became more market-dependent, but maize farmers generally also commercialized a significant share of their maize production. Thus, the comparisons here did not so much involve permanent transformations from subsistence to cash crop farming, but rather partial substitutions of cash crops for traditional crops by generally market-integrated farmers. This distinguished this case from others in the crop commercialization literature which often deal with a complete and permanent transformation from subsistence crops to cash crops. This is useful to bear in mind when comparing the results here with those reported in the literature. A number of issues related to crop diversification/commercialization among smallholder farmers were detailed in the introductory section. We shall review our results in light of these.

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[7] Estimated from the four skinfold measurements and gender-specific equations provided by Durnin and Rahaman (1967).

The income-effect of substitutions among crops generally depends on the relative net returns of different crops, and on whether the adoption of non-maize crops is ecologically constrained and whether it is reversible. Global figures on relative gross margins suggest that positive farm income differentials could be expected from diversification, and indeed the results here indicated positive per capita income differentials with maize farmers for potato, wheat and vegetable growers in general. The largest relative income gains were among the smallest wheat and vegetable farms, a finding which was consistent with the conclusions from the Guatemalan export vegetable crop case study (von Braun, Hotchkiss and Immink, 1989). However, small potato farmers were at some risk of a relative income loss compared to small maize farmers. The reasons for this remains to be explored. Lack of adequate access to potato markets and of efficient potato marketing institutions may have been among some of the reasons. The result was consistent with the fact that these farm households had the greatest need to engage in off-farm employment, most likely in coastal areas which involved considerable private costs due to adverse health conditions and exploitative working conditions.

A second issue dealt with increased vulnerability to food insecurity due to reduced food availability from own production. This may have been true if we focus on maize consumption among potato- and vegetable-growers versus maize farmers, and on potato consumption among wheat- and vegetable growers versus potato farmers. Both diversified and maize farmers included in the study were highly commercialized (at least on the output side), and their own production was a relatively unimportant source of food for household consumption. Thus, more important in this setting was what happened to per capita food expenditures. Overall the income elasticity of food-expenditures and the food expenditure elasticity of dietary energy intakes, at both the household- and individual level were low (at least in the short-run). This has also been shown elsewhere (Bouis and Haddad, 1990).

Potato farmers' households were the most vulnerable to inadequate energy and protein intakes, while wheat and vegetable growers' households were generally not better off than maize farmers' households, in spite of substantial income differentials. Preschool children were, relative to the households they belonged to, significantly more vulnerable to inadequate energy and protein intakes, and increasingly more so the more the household food intake was constrained.

The nutritional quality of daily diets of households and of preschoolers did not seem adversely affected by crop diversification, but at the same time no significant improvements in nutritional quality were associated with more foods being available from own production, or with significant household income increases. This result needs to be interpreted with caution, since micronutrient intake and not nutrient status was measured, and the former was likely to be subject to seasonal variation.

Preschool children of potato farmers were the most likely to be stunted and weight deficient. Significant income increases will be required to reduce the prevalence of stunting in preschool children, which can only be expected in the long-run and which finding conforms to a similar finding of the previously quoted Guatemalan export-vegetable case study. Mother's literacy can reduce the risk of severe stunting. Among school-age children, an adequate supply of protein at the household level can also significantly reduce the risk of severe stunting. With the exception of children of potato farmers, crop diversification did not adversely affect child nutritional status, but did not result in improvements, either. This requires further investigation, and may have reflected increased daily energy expenditure levels which were barely compensated for by small increases in daily energy intake associated with income increases. Adult males and females, particularly on large vegetable-growing farms, appeared to be less energy-constrained than on other farms, because of a more significant substitution of hired for household labor. Time allocation and activity pattern change, along with the division of tasks within the household, may have played an important role in determining changes in energy expenditure patterns of different household members and effects on their nutritional status.

We conclude that the previously signaled negative household effects associated with crop diversification among smallholder farmers seemed to apply to small potato farmers, but not to wheat- and vegetable growers, or to potato farmers with larger farms. Yet no significant improvements in household and individual food security seemed to have been associated with income increases among diversified farmers. This last finding is consistent with those from the IFPRI case studies described in the introductory section. It points to the need for agricultural production programs to be complemented by social investment programs in health and education in order to produce short-term, positive nutrition outcomes.

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TABLE I

Socio-economic and demographic characteristics of smallholder farm households, by crop pattern, Western Highlands, 1987

Characteristic	Farmer group MF	PF	WF	VG
	(percent distribution)			
1. Farm size (ha.):				
< 0.5	50.2	18.5	10.8	17.3
0.5 - 1.0	20.3	34.7	25.8	24.1
1.0 - 2.0	17.7	27.9	28.3	26.5
> 2.0	11.9	18.9	35.0	32.1
2. Cropland extension (ha.):				
≤ 0.5	54.5	31.6	23.3	37.0
> 0.5	34.5	68.4	76.7	63.0
3. Head of household				
a. literate	50.2	55.6	63.6	54.2
b. some formal education	45.9	48.4	59.8	51.3
4. Spouse				
a. literate	22.9	16.4	35.6	32.5
b. some formal education	21.5	16.0	31.9	30.7
5. Household size				
1-3 members	14.8	12.7	10.1	9.0
4-6 members	49.8	49.2	46.2	39.1
> 6 members	35.4	38.1	43.7	51.9
6. Credit/techn. assistance received - previous year				
a. None	71.9	23.7	46.7	29.4
b. Credit only	6.4	20.0	20.8	15.3
c. Techn. assist. only	5.1	11.1	3.3	6.1
d. Credit and techn. assit.	16.6	45.3	29.2	49.1

Note: MF - maize farmers (n=313)
PF - potato farmers (n=190)
WF - wheat farmers (n=120)
VG - vegetable growers (n=163)

TABLE II

Per capita monthly income, per capita food and non-food expenditures of smallholder farm households, by cropland extension class, Western Highlands, 1987

	All				≤ 0.5 ha				> 0.5 ha			
	MF	PF	WF	VG	MF	PF	WF	VG	MF	PF	WF	VG
	(weighted medians)											
Per capita monthly income (Q)[1]	47.3	51.0	58.2	54.7	45.8	41.7	59.7	54.6	50.0	55.2	57.7	54.9
Per capita food expenditures (Q)[1]	20.0	19.4	23.0	21.2	19.6	15.8	25.1	20.7	20.6	21.0	22.4	21.4
Per capita non-food expenditures (Q)[1]	25.9	26.9	30.8	30.5	25.3	23.2	32.0	31.0	26.7	28.5	30.6	30.0

[1] quetzal (Q) = .40 US$ (in 1987)

Note: MF - maize farmers
PF - potato farmers
WF - wheat farmers
VG - vegetable growers

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TABLE III

Per capita consumption of household-produced crops (lbs/year) by smallholder farm households, by cropland extension class, Western Highlands, 1987

Crops	All				≤ 0.5 ha				> 0.5 ha			
	MF	PF	WF	VG	MF	PF	WF	VG	MF	PF	WF	VG
	(weighted medians)											
Maize	67.4	63.2	79.5	55.6	59.1	59.3	75.5	38.3	84.4	65.0	80.8	64.8
Beans	7.9	6.0	6.6	7.9	5.4	6.0	8.5	7.6	9.8	6.0	5.7	8.0
Potatoes		69.3	55.1	34.9		53.6	90.3	39.5		76.6	47.6	32.2
Wheat			2.0				4.6				1.9	
Broccoli				1.1				3.0				0.8
Cauliflower				8.2				7.9				8.5
Cabbage				3.7				6.1				2.4
Red beets				18.7				24.4				16.1
Carrots				36.7				51.7				25.4

Note: MF - maize farmers
PF - potato farmers
WF - wheat farmers
VG - vegetable growers

TABLE IV

Dietary energy and protein intakes of smallholder households and preschool-age children (12-60 months), Western Highlands, October-November, 1987

Adequacy levels	MF		PF		WF		VG	
	Hshld	Preschooler	Hshld	Preschooler	Hshld	Preschooler	Hshld	Preschooler
	(percent distribution)							
Dietary Energy Intake								
< 80%	16	54	22	74	15	55	16	57
80-100%	23	24	33	13	24	24	23	18
> 100%	61	23	45	13	62	21	61	24
Protein Intake								
< 80%	6	25	7	23	8	26	4	23
80-100%	10	15	18	25	12	16	9	11
> 100%	84	60	74	52	80	58	87	66

Note: MF - maize farmers
PF - potato farmers
WF - wheat farmers
VG - vegetable growers

TABLE V

Probit models to estimate determinants of adequate dietary energy and protein intakes of smallholder farm households and preschool-age children, Western Highlands, 1987

Indepdent variables	Household		Preschooler	
	Dietary Energy[1]	Protein[1]	Dietary Energy[1]	Protein[1]
VAR1	-.163(2.44)**	-.308(4.06)*		
VAR2			-.020(2.90)*	-.001(0.66)
VAR3	.054(0.43)	-.194(1.38)	-.490(2.42)**	-.400(2.38)**
VAR4			.132(0.88)	-.083(0.57)
VAR5	.266(0.85)	-.068(0.21)	.247(0.65)	.583(1.34)
VAR6	.003(0.40)	.014(1.43)		
D1	.286(2.26)**	.330(2.39)**	.311(1.76)***	.196(1.20)
D2	.031(0.20)	.246(1.49)	.003(0.01)	.157(0.79)
D3	.100(0.73)	-.036(0.23)	-.027(0.15)	-.115(0.63)
Constant	-.820(1.47)	-.568(0.92)	1.502(2.59)*	-.220(0.42)
Chi-square	16.19	28.55	19.12	14.63
($p < X^2$)	(.023)	(.002)	(.008)	(.041)

VAR1: 1,2,3 terciles of the overall per capita income distribution
VAR2: per capita food expenditures
VAR3: household size: "1": <5 members; "2": ≥5 members
VAR4: mother's literacy status "1": yes; "0": no
VAR5: self-consumption share in total income "0" = 0; "1" = >0
VAR6: percent of food expenditures/total income
D1 : dummy variable: potato farmer : "1"; else: "0"
D2 : dummy variable: wheat farmer : "1"; else: "0"
D3 : dummy variable: vegetable grower: "1"; else: "0"

[1] coefficient = probit estimate (t-ratio)
* p< 0.01
** p< 0.05
*** < 0.05 < p < 0.10

TABLE VI

Prevalence of stunting and weight deficiency among preschool children of smallholder farm households, by farmsize class, Western Highlands, 1987

Anthropometric indicator	Farm size: Lower tercile				Middle tercile				Upper tercile			
	MF	PF	WF	VG	MF	PF	WF	VG	MF	PF	WF	VG
	(percent distribution)											
Height/age												
> - 2SD	17	3	13	24	25	4	23	15	16	19	38	23
-2 to -3SD	34	10	38	41	25	37	23	35	26	25	41	26
< - 3SD	49	87	50	35	50	59	55	50	58	56	21	51
Weight/age												
> - 2SD	42	25	50	47	53	37	32	58	55	47	64	66
-2 to -3SD	32	47	25	41	35	41	32	23	36	34	33	30
< -3SD	26	28	25	12	13	22	36	19	10	18	8	4

Note: MF - maize farmers
PF - potato farmers
WF - wheat farmers
VG - vegetable growers

TABLE VII

Probit models to estimate determinants of stunting in preschool-age and school-age children of smallholder farm households, Western Highlands, 1987

Indepdent variables	Preschool children (12-60 months)		Male children (6-15 years)		Female children (6-15 years)	
	Model 1[1]	Model 2	Model 1	Model 2	Model 1	Model 2
VAR1	-.190(1.85)***	-.175(2.00)**	-.175(1.45)	-.059(0.54)	-.191(1.59)	-.161(1.21)
VAR2	-.219(1.32)	-.303(2.01)**	-.258(1.21)	-.209(1.39)	-.216(1.26)	-.274(1.56)
VAR3	.100(0.87)	-.060(0.60)				
VAR4			.135(0.67)	.316(1.68)***	-.031(0.15)	.316(1.55)
VAR5	-.359(1.80)***	-.116(0.71)	-.524(1.63)	-.648(2.65)*	-.331(1.15)	-.479(1.90)***
VAR6	.140(1.33)	.024(0.27)	.143(1.22)	-.048(0.46)	.095(0.78)	-.116(1.00)
VAR7	-.039(0.22)	-.019(0.13)	.356(1.72)***	.163(0.84)	.213(1.10)	-.092(0.50)
D1	.261(1.08)	.311(1.70)***	.451(1.63)	.550(2.43)**	-.142(0.55)	.121(0.52)
D2	.405(1.73)***	-.294(1.39)	.302(1.07)	.027(0.11)	-.389(1.38)	-.401(0.15)
D3	-.281(1.31)	-.004(0.02)	-.001(0.01)	.276(1.19)	-.427(1.68)***	.134(0.56)
Constant	1.675(3.42)*	.724(1.73)***	.941(1.26)	.164(0.26)	1.458(2.20)*	.718(1.21)
Chisquare	24.74	25.72	22.40	19.49	14.51	9.36
($p < X^2$)	(.003)	(.002)	(.008)	(.021)	(.105)	(.405)

Model 1: 1: < - 2SD; 0: ≥ - 2SD (HT/AGE)
Model 2: 1: < - 3SD; 0: ≥ - 3SD (HT/AGE)
VAR1: 1,2,3: terciles of the overall per capita income distribution
VAR2: mother's literacy: 1: yes; 0: no
VAR3: child's energy intake status; adequacy: 1: <80%; 2: 80-100%; 3: > 100%
VAR4: household's energy intake status, adequacy: 1: <100%; 2: ≥ 100%
VAR5: child's/household's protein intake status: 1: <100%; 2: ≥ 100%
VAR6: household mandays/hectare of cropland/yr: 1,2,3: terciles of overall distribution
D1 : dummy variable: potato farmer : "1"; else: "0"
D2 : dummy variable: wheat farmer : "1"; else: "0"
D3 : dummy variable: vegetable farmer: "1"; else: "0"

[1] coefficient = probit estimate (t-ratio)

* $p < 0.01$
** $p < 0.05$
*** $p < 0.05 < p < 0.10$

TABLE VIII

Prevalence of stunting and weight deficiency among school-age children (6-15 years) of smallholder farm households, by farmsize class and gender, Western Highlands, 1987

Farmsize class:	Farmer group:	Gender	Height/age			Weight/age		
			>-2SD	-2 to -3SD	<-3SD	>-2SD	-2 to -3SD	<-3SD
			(percent distribution)					
Lower tercile	MF	M	25	48	27	56	38	6
		F	16	42	42	58	40	2
	PF	M	9	36	55	36	55	9
		F	29	29	43	64	36	0
	WF	M	13	88	0	75	13	13
		F	20	80	0	80	20	0
	VG	M	17	42	42	50	50	0
		F	25	25	50	63	38	0
Middle tercile	MF	M	19	39	42	50	39	12
		F	19	47	34	66	34	0
	PF	M	16	38	47	50	34	16
		F	27	46	27	55	36	9
	WF	M	21	43	36	57	36	7
		F	13	25	63	50	38	13
	VG	M	23	36	41	64	36	0
		F	33	33	33	75	25	0
Upper tercile	MF	M	36	27	36	73	23	6
		F	24	44	32	68	24	8
	PF	M	8	36	56	48	44	8
		F	14	41	46	65	35	0
	WF	M	21	42	38	46	54	0
		F	39	35	26	70	30	0
	VG	M	31	38	31	62	35	8
		F	39	31	31	81	19	0

Note: MF - maize farmers
PF - potato farmers
WF - wheat farmers
VG - vegetable growers