Determining the contribution of agricultural production to household nutritional status in KwaZulu-Natal, South Africa

Johann Kirsten, Robert Townsend & Chris Gibson

1. INTRODUCTION

Strategies for alleviating nutritional deficiencies in households have been a topic of continued debate in academic and political discussion. A common argument, in the case of rural households, is that an increase in food production could improve household nutrition, and this reasoning has been used to motivate programmes aimed at improving agricultural productivity in less-developed and poverty-stricken areas. In the former homeland areas of South Africa households are highly susceptible to malnutrition and programmes for improving agricultural productivity have been implemented. The region's poverty and low agricultural production justified the focus on agriculture. Farmers in these areas have been excluded (almost exclusively) from the mainstream agricultural sector, and agricultural development programmes have had limited success in bringing about the required increase in agricultural productivity. This has led to a change in the nature of development programmes by increasingly focusing on improved access to inputs, markets and other agricultural services for empowering farmers to improve their agricultural productivity. Several studies were commissioned to evaluate the success of these programmes in different regions (Kirsten et al, 1993; Lyne & Ortmann, 1992). Mixed results were reported but, in general, improved availability of inputs (seeds and fertilisers), access to credit, and extension and training services led to a sharp rise in yields and productivity in many regions (Kirsten, 1994; Chikanda & Kirsten, 1996; Van Rooyen & Nene, 1996; Lyne & Ortmann, 1992). The link between this increased productivity and reduced malnutrition was, however, never firmly established.

As a result, a survey was commissioned among rural households in the former KwaZulu homeland of South Africa to determine whether unproved delivery of agricultural services and inputs contributed to improved nutritional status. This article uses the data from this survey to explore the relationship between nutritional status and agricultural production amongst a sample of rural households in South Africa. As past studies of rural households have focused on either agricultural or socio-economic aspects of households, this study is a first attempt to consider household agricultural data and nutritional data together in the South African context. The methodology applied in this study is similar to that used by other studies in Africa (Kennedy & Cogill, 1987; Kennedy, 1994; Kumar, 1994).

The next section provides a brief overview of household characteristics, with agricultural production being the focus of Section 3. Section 4 describes the nutritional status of households as measured by anthropometric indices. These indicators of nutritional status are then analysed by means of an ordinary least squares regression and a logit maximum likelihood procedure to determine the factors (household characteristics and agricultural activities) influencing the nutritional status of households. The final section presents the conclusions of the study.

2. CHARACTERISTICS OF THE STUDY POPULATION

During March 1993, a two-part survey was conducted to assess both the delivery of agricultural services and inputs, and the nutritional status of rural households. First, a survey of 198 households in three tribal wards of the former KwaZulu was undertaken to determine household characteristics, agricultural and non-farm activities, as well as income levels. Only 173 of the questionnaires from this survey were usable. Second, a nutritional assessment was carried out in 79 of the households in the Ezingolweni and Nkandla tribal wards included in the sample of 173 households (Gibson & Fincham, 1993). A total of 142 children between the ages of 0 and 60 months in these households were measured using anthropometric techniques.

The households in this survey population live on tribal land under traditional tenure arrangements, with land being allocated to households by a tribal chief. The average household size is 8,3 persons, but families as large as 16 were also found. Around 37 per cent of households are headed by females. The literacy rate is relatively high, with 33 per cent of the population above the age of 6 years having passed at least Standard 6 (eight years of schooling). Only 11 per cent of the population have no form of education. Households in these rural areas typically earn an income from a variety of sources such as welfare payments, remittances, formal and informal employment, and crop and livestock production. An analysis of the income sources of the survey population has shown that 38 per cent of households earn an income from formal employment while 57 per cent have access to welfare payments (pensions). Only 25 households (7,5 per cent) earn cash income from crop and livestock production.

Farming accounts for roughly one sixth of total household income (on average). However, the large majority of households (over 90 per cent) are involved in some agricultural activity largely for subsistence purposes. This, in turn, indicates that a minority of households produce a surplus, or rather, market their agricultural products. Pensions are the most important source of income for the extremely poor (income less than R1 500 pa), while formal jobs are the most important source for the more affluent (income over R3 000 pa). Agriculture plays a fairly consistent role with a relatively constant contribution to income of about 15 per cent over the spectrum, except for the extremely poor (income less than R1 500 pa, or 6,4 per cent) and most affluent (income over R12 000 pa, or 8,6 per cent).

3. AGRICULTURAL PRODUCTION

The various crops grown by respondents in the survey areas are listed in Table 1. It is evident that crop production is largely of a subsistence nature and only a relatively small proportion of households sell some of their harvest. Almost all households (92,5 per cent) grow maize, but only 9,8 per cent of respondents sold any of the maize during 1992. Total maize yields average approximately 300 kg per household. Some respondents, however, recorded total yields of as high as 1 000 kg (4 per cent), 2 000 kg and 3 650 kg. The majority (41 per cent) harvest between 100 kg and 1 000 kg of maize. The recorded yields reported from this survey are particularly low due to the drought conditions experienced during the crop season in question.

Although the mean number of cattle owned by households was calculated at 3,31, it was found that 49 per cent of the respondents do not own any cattle. Ownership of cattle ranges from 1 to as high as 22, with the majority of households owning between 1 and 10 head of cattle.

Table 1: Main crops produced by respondents, 1992

Crop	Respondents who grow the crop (%)	Average total yield (kg)	Sold (% of repondents growing the crop)	Average income per seller (R)
Maize	92,5	300	9.8	136,18
Dry beans	57,2	70	9.2	31,22
Pumpkins	45,1	65	2.9	28,44
White potatoes	54,9	300	8.5	190,45
Cabbages	38,2	150	12.7	34,83

4. IDENTIFYING NUTRITIONAL RISK AMONG HOUSEHOLDS: KEY ANTHROPOMETRIC INDICATORS

The use of anthropometry as a tool for identifying nutritional risk and failure to grow has received considerable attention over the last twenty years. There is much debate about small size and malnutrition; smallness being used as a predictor of unfavourable health outcomes (Morley & Woodland, 1972; Waterlow, 1982). In essence, being small is not detrimental to the individual except in two instances: size and its impact on maximal physical working capacity and the capacity for sustained work or endurance. Of central concern in the issue of size are the factors that predispose the individual or group to become small - poor diet and ill-health are invariably linked to poverty. As such, identification of failure to grow sheds light on the socio-economic status and state of development of the group under survey. A further implication of the link between nutrition and development is that nutritional assessment cannot be done in isolation. Different anthropometric measurements measure different attributes of the individual or groups of individuals, and it is therefore essential to interpret the results in the light of the particular measures used. In this article it is assumed that the measurements are taken as a one-time assessment of representative samples of the black rural population in KwaZulu.

The measurements chosen are those of height-for-age (H/A), weight-for-age (W/A) and weight-for-height (W/H). Trends in H/A reflect long-term changes in the physical and social environment, and their nutritional consequences. Those children who are short for their age, according to an agreed reference standard, are referred to as being *stunted*. Trends in W/H or W/A reflect short-term changes in food consumption and/or disease experience, and in those who do not perform adequately the condition is referred to as *wasting*.

It is generally agreed that the age at which children are most susceptible to nutritional stress is in the weaning period, between birth and 5 years of age. The survey of 0 to 60-month-old children thus represents the best age group on which to base an anthropometric survey. There are numerous means for arriving at the percentage of cases in a sample that are at nutritional risk. Some 'reference standard' or norm is commonly used against which to assess the particular survey result. In the case of the present study, norms of the National Centre for Health Statistics (NCHS) have been taken as the reference because of their wide international use and acceptance. The actual cut-off point, at which nutritional stress or risk is considered significant, is always open to debate. In this study, the method adopted was to take all those who fell below the third centile on the NCHS norms as being at nutritional risk. The implication is that children who fail to reach the third centile on these norms have, for example, attained less than 80 per cent of the 50th percentile (median) of weight-for-age or 90 per cent of height-for-age, and are considered at risk for increased morbidity.

Since the surveys show similar results for the Ezingolweni and Nkandla communities, the results are considered together. A number of aspects from the results are worth underlining:

- The H/A results show greater numbers and percentages of children at risk than those from the W/A and W/H assessments.
- The H/A results show males at higher risk than females - 35 per cent and 25 per cent respectively.
- The greatest number of males and females at risk, according to the H/A results, peaks after the first year.
- Relatively few children are at risk according to the W/A and W/H assessments.

The details of these results are presented in Table 2, which compares the numbers of children at risk using simple centiles, as well as standard deviation (SD) units.

Table 2: The prevalence of low anthropometry using centiles (less than the third centile) and standard deviation units (less than 2 SDs) (%)

Gender	Number	Height-for-age		Weight-for-height		Weight-for-age	
		Less than 3 centiles	Less than 2 SDs[1]	Less than 3 centiles	Less than 2 SDs	Less than 3 centiles	Less than 2 SDs
Males (0-60 months)	62	35,5	30,7	1,6	1,6	6,5	6,5
Females (0-60 months)	71	25,5	22,4	1,4	0	8,5	8,5

Note: 'Less than two standard deviations from the mean.

The results show that the incidence of children at risk, according to the W/H and W/A assessments, is low. This suggests that at the time of the survey, food intake for the children in the samples was in most cases adequate. However, the W/A incidence is indicative of a potentially deleterious situation - these figures are on a par with those solicited from other studies of poor communities in South Africa. On the other hand, the incidence of stunting in the communities surveyed is high. Again these figures correspond with those from similar studies. Low levels of wasting and high levels of stunting signify communities that are always close to the 'survival level' over a long period of time. These communities are not experiencing famine conditions, but rather situations of food and resource scarcity, and of poverty.

4.1 Characteristics of households with undernourished children

Tables 3 to 5 present characteristics of households with undernourished children. These tables are largely descriptive in nature and reflect a number of results that are largely expected. Interesting to note is the difference in family size between the two groups of households. The households with stunted children are clearly larger and therefore also have a higher dependency ratio as one would expect. The anthropometric indicators, H/A, W/A and W/H, show some consistency with the stunted/non-stunted measure of nutrition.

Table 3: Characteristics of households with stunted and non-stunted children

Average	Stunted (28)	Non-stunted (51)
Average number of people in household	11	9
Average people per household involved in agriculture	2	2
Dependency ratio	,27	1,16
Height-for-age (average Z-score)	-1,99	-0,51
Height-for-age (median)	92,36	97,92
Weight-for-age (average Z-score)	-0,97	0,07
Weight-for-age (median)	89,81	99,67
Weight-for-height (average Z-score)	3,37	0,54
Weight-for-height (median)	99,50	103,68
Number of children underweight	8	0
Number of children wasted	1	0
Average number of children per household	2,46	1,53

The working status of the parents in the two groups is similar, except that the households with stunted children generally have more females as the head of the household - which could reflect poorer households. The effect of lower household income on nutritional status is clearly illustrated by the results in Table 4. The largest income difference between the groups is apparent in crop income. In households with non-stunted children, crop income is almost three times more than in households with stunted children. Other, although less extreme, differences occur in income from informal jobs and remittances.

4.2 Agricultural activities of households with well-nourished and undernourished children

Having identified agricultural incomes, particularly from crops, as the largest source of income variation, this section will extend the analysis of agricultural activities. Tables 5 to 6 provide a profile of the agricultural activities of the two groups of households identified earlier. In terms of livestock holding, there does not seem to be much difference between households with stunted children and households without, while the statistics on crop activities (Table 6) clearly reflect a greater involvement among the households with well-nourished children.

A closer examination of Table 5 suggests that although there are differences between groups in the number of respondents owning cattle, these differences are significantly reduced when percentages are compared. The households with non-stunted children appear to have a slightly larger number of cattle with on average 3,3 head, while those without stunted children own 4 head of cattle.
Of the 42 households in the sample that owned cattle, 33 per cent were households with stunted children while the majority (67 per cent) were households with non-stunted children. Some 38 per cent of the 52 households owning chickens had stunted children while the majority (62 per cent) of the households owning chickens had no nutritional problems. While this description illustrates a fairly small difference, larger variations between groups are apparent in Table 6, with significant differences in crop cultivation and crop sales income, particularly for maize and pumpkins. While these comparisons have provided some description of the farm and non-farm activities of households of different nutritional status, a more formal analysis is required and is presented in the next section.

5. DETERMINANTS OF NUTRITIONAL STATUS OF HOUSEHOLDS

Using the anthropometric indices discussed above, this section determines the factors influencing the nutritional status of households. It is argued that preschoolers aged between 0 and 60 months are the most vulnerable and that the anthropometric indices of these children would provide a good guide to the households' nutritional status. The main purpose of this analysis is to determine the link between agricultural production and child nutrition and not, like several other studies (see Von Braun & Kennedy, 1994; Kennedy & Cogill, 1987), to analyse the impact of agricultural commercialisation on household nutrition.

In order to model the determinants of child nutritional status, it is assumed that exogenous factors will have a major impact on the dietary intake of children. Ideally, variables providing an indication of the health and sanitation environment, dietary intake and seasonal effects would be required to provide a good prediction of the factors influencing household nutritional status (Kennedy & Cogill, 1987; Kumar, 1994). In addition, several follow-up surveys usually also lead to better results. This study makes use of a one-off survey and links house hold characteristics, income data (farm and non-farm) and information on households' agricultural activities to household nutritional status. It is therefore postulated that child nutrition is affected by the age and gender of the child, the number of people in the household (and also the number of dependants), household income and the extent of agricultural activities. Included in the models are variables related to household characteristics, income and crops produced, and a number of variables indicating the adoption of new technology such as the use of chemical fertiliser and hybrid seed. The argument is that households with stronger involvement in agricultural activities should have a better nutritional status.

Table 4: The working status of parents and average annual household income

Working status	Stunted (28) Number	Stunted (28) Percentage	Non-stunted (51) Number	Non-stunted (51) Percentage
Father works away	12	42,8	22	43,1
Mother works away from home	4	14,2	5	9,8
Both parents work	2	7,1	2	3,9
Female head of household	11	39,2	11	21,5
Source of income	**Number**	**Rand**	**Number**	**Rand**
Remittances	27	R3 862,22	50	R4 299,00
Pension	24	Rl 719,75	40	Rl 511,55
Informal jobs	3	Rl 040,00	8	R2 180,00
Livestock	3	R371.67	4	R405.00
Crop	8	Rl 191,50	12	R3 480,25
Total income	28	R8 185,14	51	Rl 1875,80

Table 5: Livestock, ownership and activities

	Non-stunted (51)					Stunted (28)				
Livestock, ownership and activities	Cattle	Goats	Chicken	Pigs	Donkeys	Cattle	Goats	Chicken	Pigs	Donkeys
Number of respondents with livestock	28	16	34	10	1	14	9	20	2	2
Percentage respondents with livestock	54,9	31,3	66,6	5,1	1,9	50,0	32,1	71,3	7,1	7,1
Average value of livestock	R3585	R1416	R119	R106	R0	R3400	R1620	R118	R80	R120
Average number slaughtered	1,7	4	8.5	2	0	1,6	3	8,7	0	0
Average number given away	2,6	0	4	0	0	6	0	0	0	0
Average total value of sales	R1200	RO	R65	R290	R0	R0	R500	R79	R540	R0

Table 6: Crops and vegetables grown and sold by households with stunted and non-stunted children

Crops and vegetables	Cultivate (%)		Subsistence (%)		SoId(%)		Crop income (rand)	
	Non-s	S	Non-s	S	Non-s	S	Non-s	S
Maize	96,1	89,3	88,2	85,7	7,8	0	R2890	R0
Beans	62,8	67,9	52,9	60,7	9,8	10,7	R360	R453
Sorghum	7,8	7,1	5,9	7,1	0	0	RO	R0
Sweet potatoes	7,8	0,0	9,8	0	0	0	R0	R0
Madumbies	19,6	7,1	19,6	7,1	0	0	R0	R0
Groundnuts	0	3,6	0	3,6	0	0	R0	R0
Pumpkins	54,9	32,1	49,0	32,1	5,9	0	R125	R0
White potatoes	58,8	60,7	43,1	35,7	15,7	25,0	R802	R780
Calabashes	5,9	0	7,8	3,6	2,0	0	R0	R0
Cabbages	39,2	46,4	27,5	28,6	9,8	14,3	R294	R573
Tomatoes	9,8	21,4	5,9	17,9	3,9	3,6	R105	R5
Onions	25,5	28,6	19,6	14,3	0	10,7	R0	R98
Carrots	15,7	17,9	13,7	14,3	0	0	R0	R0
Chilli	17,7	10,7	17,7	10,7	2,0	0	R20	R0
Spinach	37,3	35,7	29,4	21,4	7,8	7,1	R53	R90
Beetroot	25,5	14,3	19,6	10,7	0	0	R0	R0
Peas	9,8	17,9	9,8	17,9	0	0	R0	R0

Notes: Non-s=Non-stunted; S = Stunted.

Table 7: Regression of pre-schooler Z-scores and percentage of median for height-for-age and weight-for-age indices[1]

Independent variable	Height-for-age				Weight-for-age			
	Percentage of median		Z-scores		Percentage of median		Z-scores	
	δi	t-vatue	δi	t-value	δ1	t-value	δi	t-value
Constant	96,40	37,16	-0,97	-1,44*	93,57	12,41**	-0,68	-1,06
Demographic variables	-0,48	-0,56	-0,13	-0,59	-4,34	-1,75**	-0,34	-1,62**
Gender	-0.02	-0.91	-0.01	-0.53	-0.07	-0.94	-0.01	-1.03
Age	-0.28	-2.12**	-0.07	-2.11**	-0.33	-0.86	-0.02	-0.68
Household size	-1,77	-1,66**	-0,46	-1,66**	-1,58	-0,51	-0,15	-0,54
Female-headed household	0,08	0,18	0,81	0,15	-0,94	-0,69	-0,08	-0,69
Non-farm activities	-0,64	-0,77	-0,16	-0,74	-2,08	-0,85	-0,88	-0,88
Number of formal employees	0,01	0,31	0,01	0,28	0,01	0,35	0,01	0,59
Number of informal employees	1,95	1,75*	0,50	1,72**	1,12	1,98**	0,16	2,01*
Total household cash income	2,18	1,31*	0,56	1,39*	10,34	1,73**	0,90	1,67**
Farm activities	0,01	0,04	0,01	0,04	0,59	0,18	0,03	0,10
Pumpkins produced	1,72	1,36*	0,42	1,30*	4,70	1.30*	0,42	1,32**
Maize produced	1,97	2,00**	0,50	1,93**	6,33	2,21	0,52	2,09
Technology adoption								
Purchases seed								
Purchases fertiliser								
Uses a hoe								
R^2	0.12		0.12		0.13		0.13	
Degrees of freedom	130		130		130		130	

Note: 'While retaining the non-significant variables in the model reduces the overall significance of the model, it does allow for transparency between significant and non-significant variables. The model significance level is obviously strengthened if the non-significant variables are removed.

5.1 A multivariate regression

In order to test this hypothesis, a multivariate regression analysis was used with nutritional status, the percentage of the median and Z-scores for height-for-age and weight-for-age measures as the dependent variable. The multivariate regression model can be expressed as follows:

$$y_i \, \delta_0 + \sum_{i=1}^{n} \delta_i \, x_i \qquad (1)$$

where y_i is the nutritional status of the household measured as the percentage of the median and Z-scores for height-for-age and weight-for-age ratios; x_i are the explanatory variables including household characteristics, farm and non-farm activities and technology adoption variables as represented in Table 7. These include both continuous and dichotomous variables. The continuous variables are age, household size, the number of formal employees, the number of informal employees and total household income. The dichotomous (1/0) variables are as follows:

Gender:	1 for a boy and 0 for a girl
Female-headed household:	1 if headed by a female and 0 if headed by a male
Maize produced:	1 if the household produces maize and 0 if it does not
Pumpkins:	1 if the household produces pumpkins and 0 if it does not
Purchases seed:	1 if the household buys seed and 0 if it does not
Purchases fertiliser:	1 if the household buys fertiliser and 0 if it does not
Owns a hoe:	1 if the household owns a hoe and 0 if it does not

From the results presented in Table 7, it is evident that there is a strong relationship between child nutrition and the crops grown by households, as well as the technology used in the production process. It is argued that children in households growing maize and pumpkins will be better nourished. An increase in household size has a significantly negative effect on child nutrition. Given the relative poverty of these households this result was expected. Children in households headed by females seem to be nutritionally worse off than other children in the sample. The negative signs of the coefficients for the number of formally and informally employed members of the household are contradictory, since one would expect that higher employment would lead to higher income levels and thus better nutrition. An explanation for this could be that these family members contribute very little to the household income pool or are not always at home to contribute to childcare. The very small contribution of income levels to the nutritional measures confirms this notion. Correlation coefficient results suggest that multicollinearity is not a major factor among the explanatory variables, although household income and the number of formal employees had a coefficient of 0,4.

The significant contribution of the various technology variables, signifying adoption of new technology, is surprising. This further strengthens the argument that households which participate seriously in agricultural activities have better nutritional status. Although the R^2 of the regressions seems low, it compares well with the results of Z-score regressions of other studies (eg Kennedy & Cogill, 1987; Kumar, 1994). The low explanatory power of the model suggests that the majority of the variations in the nutritional scores are not explained by the variables included. The inclusion of other variables, such as access to medicine, could increase the model's explanatory power. Trying to explain a continuous variable with dichotomous variables, however, may have exacerbated this poor result. In order to avoid this possible bias, a logit model will be used to extend the analysis.

5.2 A logit model

The second approach used in the analysis is the estimation of a logit model to determine the factors that would identify stunted children in a household. A dummy variable was created to indicate the occurrence of stunted children in a household (stunted = 1). Logit models can accommodate this binary dependent variable (Aldrich & Nelson, 1984). The model can be expressed as follows:

$$\log\left(\frac{P(y=1)}{1-P(y=1)}\right)=\beta_0+\sum_{i=1}^{n}\beta_i x_i \quad \text{or as} \quad \left(\frac{P(y=1}{1-P(y=1)}\right)=e^{(\beta_0+\sum_{i=1}^{n}\beta_i x_i)} \qquad (2)$$

where P is the probability that y = 1 and x is the set of explanatory variables. In this analysis x will contain both dichotomous and continuous variables as in the multivariate regression in the previous section. In the second expression in Equation (2), the left-hand side represents the odds of an event occurring (in this case, of a household member being stunted) and the right-hand side gives the marginal effects of x; on the odds.

The explanatory variables again include household characteristics, farm and non-farm activities and technology adoption variables. The results are reported in Table 8. The goodness of fit of the model measures the proportion of observations that correctly predict values of the dependent variable. The specified model provided an encouraging result with a goodness of fit of 78 per cent. All the variables, except total household income, are significant, confirming again the notion that households involved in agriculture have a lower probability of having stunted children. The exponential of β_i column (exp(β_i) in Table 8 shows the odds of an event occurring versus not occurring, per unit change in an explanatory variable. Using this interpretation, the odds on maize and pumpkin producers being stunted are 0,11 and 0,26 times that of non-producers. This implies that those households producing maize and pumpkins have a very small probability of having stunted children. Alternatively, those households not producing maize and pumpkins, and thus not involved in agricultural activities, have a greater chance of having malnourished children.

Again the technology variables featured strongly in the model, indicating that households buying seeds and using improved cultivation techniques in the production process would have a lower probability of having stunted children. The odds on households using purchased seed having stunted children are 0,48 and 0,49 times that of households not using these technologies. This indicates the importance of agricultural production for the nutritional status of poor rural households and confirms that access to agricultural services and inputs could have a positive effect on household nutrition.

Table 8: Results of logit model estimation with stunting (1/0) as dependent variable

Independent variable	Description of variables		Stunting	
		P	t-value	**exp(P)**
Constant		2,10	1,68"	8,17
Demographic variables Gender	1/0 - male/female	0,56	1,32'	1,75
Age	Months (0-60)	-0,02	-1,72"	0,98
Number of people in household	Persons	0,28	3,83"	1,32
Non-farm activities Number of	Persons	0,57 -	1,48" -	1,77
pensioners Number of formal	Persons	0,39	1,65"	0,67
employees Number of informal	Persons	0,78 -	1,80" -	2,18
employees Total household income	Rands	0,01	1,25	0,99
Farm activities	Persons	-0,35 -	-2,30" -	0,70
Number of people in agriculture	1/0: produce/don't	2,17 -	2,73" -	0,11
Maize produced Pumpkins produced	1/0: produce/don't	1,33	2,82"	0,26
Technology adoption variables	1/0: purchase/don't	-0,72	-1,51'	0,48
Purchase seed				
Goodness of fit	0,78			
Number of iterations	6			
x^2	31,32**			

Notes: * = Significant at the 1% confidence level; ** = significant at the 5% confidence level.

The signs of the coefficients for the 'number of pensioners' and the 'number of informal employees' are somewhat contrary to expectations, since one would expect households with more pensioners and some income from informal sources not to have stunted children. A possible explanation for this result is that these variables provide an indication of the extreme poverty of these households and that meagre income from informal employment and/or pensions are the only sources of income, which in many larger households are not sufficient to feed everyone.

The results also show that as children grow older the odds for stunting decrease, which is consistent with the H/A results reported earlier. The odds for stunting increase by 1,32 times for every additional person added to the household. The larger the number of informally employed members in a household, the higher the incidence of stunting in children, which is similar to the result derived for the multivariate analysis. The results from both Tables 8 and 9 suggest that farm activities play a more significant role in child nutrition levels than non-farm activities.

6. CONCLUSION

This article explored the relationship between nutritional status and agricultural production amongst a sample of rural households in the KwaZulu-Natal province of South Africa. Results from a nutritional assessment of children between 0 and 60 months revealed that 35 per cent of households have stunted children. The occurrence of underweight children was less (10 per cent of households) but they were from the same households. Results from regression analyses and a logit model show that household size has a significantly negative effect on child nutrition, while the effect of formally and informally employed households and household income on child nutrition was inconclusive. Households with access to seeds and fertiliser, and strong family involvement in agriculture seem to be less likely to have stunted children and are therefore considered to be better nourished. These results indicate that agricultural activities make a positive contribution to household nutrition, which suggests that designing effective programmes for improving agricultural productivity in the less-developed areas of South Africa could have a potentially positive impact on household and child nutritional status.

REFERENCES

ALDRICH, JH & NELSON, FD, 1984. *Linear probability, logit and probit models.* Sage University Paper series on quantitative applications in the social sciences, No 07-045. Beverley Hills: Sage.

CHIKANDA, M & KIRSTEN, JF, 1996. Determinants of input use on smallholder farms in the former Lebowa. *Agrekon,* 35(4): 320-4.

GIBSON, C & FINCHAM, R, 1993. *Nutritional survey of Ezingolweni and Nkandla.*

Unpublished report. Durban: University of Natal. *Determining the contribution of agricultural production to household nutritional status*
KENNEDY, E, 1994. Effects of sugarcane production in south-western Kenya on income and nutrition. In Von Braun, J & Kennedy, E (Eds), *Agricultural commercialisation, economic development and nutrition.* Baltimore: Johns Hopkins University Press.
KENNEDY, ET & COGILL, B, 1987. *Income and nutritional effects of the commercialisation of agriculture in south-western Kenya.* Research Report No 63. Washington, DC: International Food Policy Research Institute.
KIRSTEN, JF, 1994. *Agricultural support programmes in the less-developed regions of South Africa.* Unpublished PhD thesis. Pretoria: University of Pretoria.
KIRSTEN, JF, SARTORIUS VON BACH, HJ & VAN ZYL, J, 1993. *Evaluation of the Farmer Support Programme (Lebowa, Lebowa, KaNgwane).* Unpublished report. Halfway House: DBSA.
KUMAR, SK, 1994. *Adoption of hybrid maize in Zambia: effects on gender roles, food consumption and nutrition.* Research Report 100. Washington, DC: International Food Policy Research Institute.
LYNE, M & ORTMANN, GF, 1992. *Evaluation of the KwaZulu Farmer Support Programme.* Second interim report. Halfway House: DBSA.
MORLEY, D & WOODLAND, M, 1972. *See how they grow: monitoring the growth of infants and children in the developing world.* London: Macmillan.
VAN ROOYEN, CJ & NENE, S, 1996. What can we learn from previous farmer development strategies in South Africa? *Agrekon*, 35(4): 325-31.
VON BRAUN, J & KENNEDY, E (Eds), 1994. *Agricultural commercialization, economic development and nutrition.* Baltimore: Johns Hopkins University Press.
WATERLOW, JC, 1982. *Nutritional assessment by anthropometry.* Unpublished typescript. Department of Human Nutrition, London School of Hygiene and Tropical Medicine. London: University of London.