DISCUSSION PAPER

Preliminary material and interim research results circulated to stimulate discussion and critical comment

I The Role of Case Studies in Farming Systems Research

II Health, Nutrition and Agriculture: linkages in farming systems research

by Simon Maxwell

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Appendix 2

Table 4: Annual Cash Flow Summary 1 October 1980 - 30 September 1981

Item	A Basic barbecho $b.	%	B Diversified barbecho $b.	%	C Diversified livestock $b.	%	D Small arado $b.	%	E Small arado $b.	%	F Diversified arado $b.	%
Cash receipts												
1. Crops sales	14950	85.75	26743	82.98	21600	54.95	50743	67.50	45770	49.47	82501	39.33
2. Livestock sales	360	4.93	5485	17.02	15705	39.96	4400	5.85	9970	10.76	-	-
3. Misc. agric. inc.	125	0.72	-	-	2000	5.08	1007	1.34	-	-	57597	27.81
4. Non-ag. income	-	-	-	-	-	-	3780	5.03	380	0.04	-	-
5. Credit/grants	1500	8.60	-	-	-	-	5700	7.58	32000	34.59	67000	32.35
6. Other	-	-	-	-	-	-	9550	12.70	4400	4.75	-	-
Total receipts	17435	100	32228	100	39305	100	75185	100	92520	100	207098	100
Cash payments												
7. Labour	3410	11.78	17453	46.21	13840	33.32	19650	21.29	12540	14.66	31492	12.61
8. Crop inputs	310	1.07	170	0.45	-	-	1450	1.57	6535	7.69	6870	2.75
9. Livestock inputs	-	-	60	0.16	730	1.76	-	-	3165	3.72	-	-
10. Capital goods	-	-	50	0.13	200	0.48	255	0.28	3200	3.76	74250	29.72
11. Contract hire	2070	7.15	100	0.26	1440	3.47	9800	10.62	9650	11.36	28180	11.28
12. Maint.and repairs	-	-	-	-	1600	3.85	350	0.38	-	-	31174	12.48
13. Marketing	1440	4.97	4360	11.54	3160	7.61	7757	8.41	8750	10.30	639	0.
14. Rent	-	-	400	1.06	-	-	-	-	-	-	-	-
15. Loan repayments	1500	5.18	180	0.48	-	-	5300	5.74	7500	8.83	35937	14.38
16. Interest on loans	500	1.72	-	-	-	-	400	0.43	-	-	6055	2.42
17. Domestic	19031	65.75	13932	36.89	14535	34.99	27080	29.34	14498	17.07	33382	13.56
18. Medical	682	2.36	1065	2.82	30	0.07	3477	3.77	11998	14.12	1370	0.55
19. Community	-	-	-	-	-	-	4550	4.93	3000	3.53	-	-
20. Other	-	-	-	-	6000	14.44	12220	13.24	4100	4.83	-	-
Total payments	28943	100	37770	100	41535	100	92289	100	84937	100	249855	100
Trading net cash flow	8205		9685		13535		16748		15990		35682	
Prsnl net cash flow	(19713)		(14997)		(20565)		(33997)		(28816)		(35252)	
Cptl net cash flow	-		(230)		(200)		145		21300		(43187)	
Total net cash flow	(11508)		(5542)		(2230)		(17104)		7583		(42757)	

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Paper II

Health, nutrition and agriculture: linkages in farming systems research

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HEALTH, NUTRITION AND AGRICULTURE: LINKAGES IN FARMING SYSTEMS RESEARCH

Simon Maxwell[1]

1. INTRODUCTION

The starting point for this paper is the evidence of a high degree of interdependence between health, nutrition and agriculture (see, for example, Chambers, Longhurst and Pacey 1981; FAO 1982; Payne 1981; Pinstrup-Anderson 1981); and the realisation that this is important to farming systems research (fsr) (Maxwell 1980b; Tripp 1982). Linkages between health, nutrition and agriculture are likely to affect (a) the characteristics of the farming system; (b) its limiting factors and opportunities; (c) the constraints within which improvements can be suggested; and (d) the likely benefit from such improvements. The practical questions to be asked in any particular case are, then:

(i) What are the likely manifestations of interdependence?
(ii) How can the magnitude and importance of these be established?
(iii) What are the implications for the research and extension programme?

To help answer these questions, the paper begins by setting out a conceptual framework for the analysis of linkages between health, nutrition and agriculture at the level of the farming household (Section 2). Higher level considerations, such as the relationship between food policy, national nutrition policy and agricultural research policy, are important and related issues, but are excluded from this discussion.[2] In Section 3, the paper addresses the question of data collection and deals with the problem of method in an area that falls between disciplinary stools. It then returns to farming systems research and in Section 4 examines the procedural changes needed to incorporate greater understanding of the linkages in a multidisciplinary and holistic research programme. All this is illustrated by a case study in Section 5, and in Section 6 some overall conclusions are drawn. It is hoped that the evidence presented will stimulate further research in what is potentially a very productive area.

There are few universal truths about the relationship between the health and nutrition status of a rural family and its pattern of agricultural activity. Farming systems vary greatly in response to physical, biological and socioeconomic conditions: clearly a land-extensive, shifting cultivation system with a bi-modal rainfall regime cannot be compared directly with an irrigated arable system operating in a semi-arid unimodal climate (Ruthenberg 1980). Nor can a small, subsistence-oriented farm involved in a complex set of reciprocal social relationships be equated with a large commercial enterprise reliant on hired labour, even if the two

are physically contiguous and closely linked in dependent or exploitative relationships (de Janvry 1981). Resource availability, activity patterns and the size, composition and use of output will be different and have a different time profile in each case, so that a highly disaggregated analysis will be required.

Farming systems research is, however, well equipped to differentiate between ideotypes in this way. It is an approach to agricultural research in which research and extension are directed to lifting the constraints or exploiting the opportunities open to specific groups of farmers. Although different interpretations exist, fsr methodologies have in common a quintessential five step procedure which emphasises the applied and holistic nature of fsr: these steps are classification of farms and farm families; diagnosis of limiting factors and opportunities; generation of recommendations; implementation; and evaluation (Norman 1980; Shaner et al. 1981; Maxwell 1984a). It is therefore particularly appropriate to approach the question of linkages with a farming systems perspective.[3]

2. Health, nutrition and agriculture: a framework for analysis

(a) Overall framework

Three streams of literature come together in designing a framework to analyse the linkages between health, nutrition and agriculture. First, there is evidence of a synergistic relationship between health and nutrition: when a person is malnourished then the probability and duration of disease rises; similarly, disease affects appetite and food utilisation and may worsen malnutrition (Scrimshaw et al. 1968, Berg 1981). As Payne (1981) points out, these links may have a social as well as a biological dimension, since illness of one member of a family (eg infant diarrhoea) may affect the nutritional status of another (eg by reducing women's contribution to agricultural labour and cutting food supplies).

A second set of literature is concerned with the relationship between agriculture on one side and health and nutrition on the other; and particularly with the effect of agricultural change processes on different social groups, especially the landless, small farm families and women (Goodman and Redclift 1981, de Janvry 1981). Agricultural and rural development may be associated with a loss of productive resources or employment opportunities for these groups, so that income falls and health and nutrition status is adversely affected. A good example is the loss of female employment in rice husking, resulting from the introduction of mechanised rice milling technologies in Indonesia, Bangladesh and elsewhere

(Timmer et al. 1983). There has been particular concern about the effect of cash cropping on domestic food supplies (FAO 1982).

A third stream in the literature is concerned with seasonality and is particularly illuminating about the effect of seasonal patterns of disease and malnutrition on the supply of agricultural labour. For example, the demand for labour may peak at the beginning of the rainy season, just when food reserves are at their lowest and body reserves have been depleted (Chambers, Longhurst and Pacey 1981).

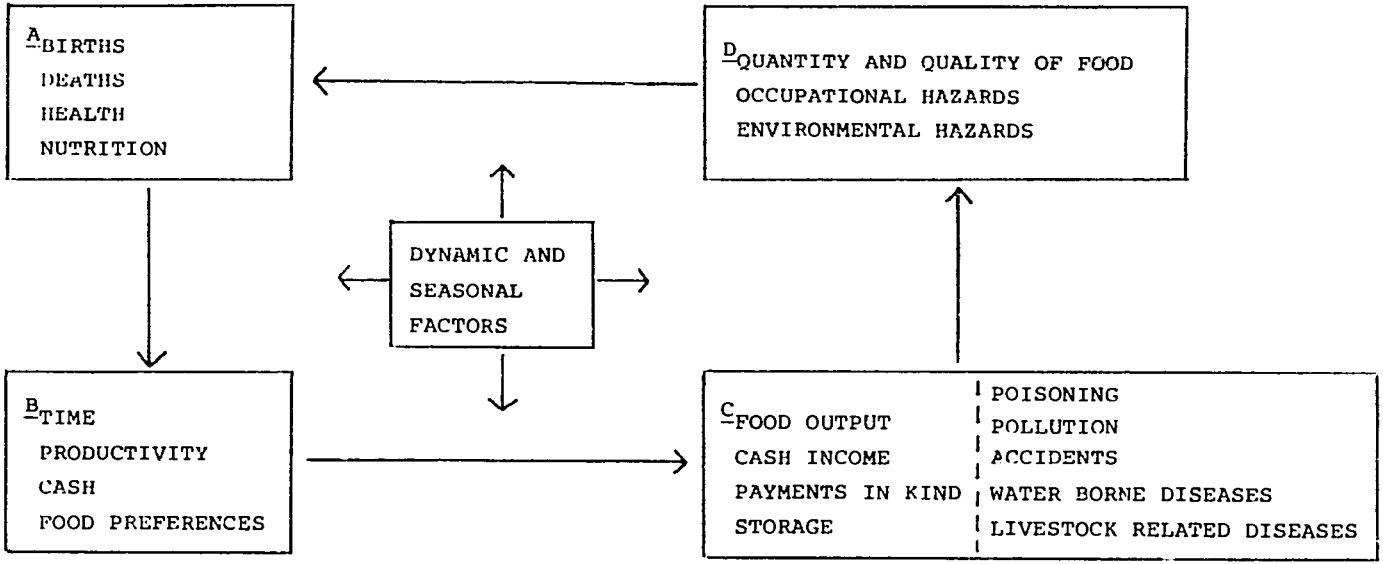
When these three streams merge and the various possible interactions are put together, a pattern of interdependence appears, summarised in Figure 1. Here the boxes on the left hand side are concerned with health and nutrition and their effect on agriculture and those on the right hand side are concerned with agriculture and its effect on health and nutrition. Box A focuses on the underlying dimensions of health and nutrition which are manifested in Box B as factors directly affecting agriculture: the time available for agriculture by different individuals, the productivity of that labour, the cash available for agriculture and the preferred pattern of food output. As Box C illustrates, these factors directly affect agricultural activities and influence food output, cash income and the receipt of payments in kind for labour sold. At the same time, agricultural activities may be associated with the dangers listed on the right hand side of Box C such as chemical poisoning, accidents or diseases carried by irrigation water or livestock. All these, in Box D, affect the quantity and quality of food produced, occupational hazards connected with agriculture and environmental hazards caused by agriculture. To complete the link, these factors in turn influence the health and nutrition dimensions included in Box A.

Thus, a picture is presented in which what happens in agriculture is greatly influenced by health and nutrition factors and vice versa. Of course, this relationship is not static: it changes over the course of a year as a result of seasonal factors and more generally as a result of dynamic influences in the natural environment or the social structure. These influences are indicated in the central box. Nor is the relationship identical for all individuals in a community. Family labour availability, for example, will be much more important for a marginal farming family which depends on selling its labour to survive, than to a family operating a large farm worked mostly by hired labour. Similarly, women and children may be affected in different ways from men, depending on their access to food and the pattern of their agricultural activity.

That the various items in the framework are important can be established by looking in more detail, first, at the way

Figure 1

HEALTH, NUTRITION AND AGRICULTURE: A FRAMEWORK FOR ANALYSIS



health and nutrition affect agriculture and, then, at the way agriculture affects health and nutrition.

(b) Health and nutrition effects on agriculture

As boxes A and B show in Figure 1, the pattern of births and deaths, of illness and of malnutrition can affect agriculture by modifying the pattern of resource supply or of output requirements. It is not just the time available that matters, but also the value of time supplied and the cash available for agriculture. Food preferences may also be important.

Births affect agriculture principally through their effect on the supply of women's labour, both at the time of birth itself and during the care of young children. There may also be significant cash expenses associated with births, for medical or social reasons, and these may take away resources otherwise used in agriculture. The effect of losing women's labour will depend on the contribution women normally make to agriculture and on the time that is lost to childbirth and infant care, and although this will vary from case to case, there is evidence that it may be substantial. Palmer (1981), for example, refers to a 'cycle in which child care and agricultural work compete for the mother's time and energy' (p.197): this results from the fact that women bear a disproportionate share of seasonal labour peaks and from the fact that births are often concentrated during a labour peak in the wet season (Crook and Dyson 1981). In some cases, health and nutrition status are sacrificed to agriculture, for example by women weaning children early to free labour during the harvest (Palmer 1981), but in other cases the reverse may be true.

Deaths of children will have similar effects to births in terms of women's time and family cash resources and there is again some seasonal pattern (Crook and Dyson 1981). However, death of an adult can have an even greater effect since it may remove the principal source of income and undermine a family's financial position to the point where productive assets have to be sold. Chambers (1983) presents case studies from different locations in which death and diseases are major factors contributing to the pauperisation of rural families.

Illness is a more pervasive influence on agriculture since it may cost time, energy and cash on a continuous basis and may affect all members of the family. There is, again, evidence that disease patterns are seasonal and may coincide with agricultural peaks: this is the case, for example, with guinea worm infestation and diarrhoeal attacks, which tend to peak in the summer (Chambers, Longhurst and Pacey 1981). Muller (1981) presents evidence on guinea worm which shows very high rates of disability and concludes that 'the maximum incidence of disease often coincides with the planting season' (p.127).

Nutrition influences both the inputs into agriculture and the outputs required from it. On the input side, malnutrition is a factor in the length and intensity of work undertaken by different individuals. Particular attention has been given to the coexistence of seasonal labour peaks with seasonal food shortages and the resulting malnutrition and low productivity (Chambers, Longhurst and Pacey 1981). Also important is the effect of long-term changes in nutritional status caused by changes in cropping patterns or land-holding which may in turn affect the supply of labour and cash to farming (Payne 1981). On the output side, food preferences will influence what crops are grown, what varieties are used and when planting or harvesting must be carried out. Tripp (1982), for example, discusses farmers' preferences for floury textured maize in Ecuador and the restrictions this poses on the maize research programme. Another example comes from Belize where attempts to bring the planting date of maize forward in order to permit more intensive cropping had to be abandoned because green maize was required at a particular time for a religious festival (P. Seager, personal communication).

To summarise: what is desired and possible in farming is affected by the health and nutrition status of a farming family, by its food preferences and by the pattern of vital events. Some of these factors will be long term and predictable, such as a preference for floury maize or the existence of a hungry season which reduces labour productivity at the busiest time of year; others may occur seemingly at random (though more often to the poor than to the rich), such as debilitating disease or a sudden death. In either case, the effects on the farm system may be significant and of long duration, reducing the ability to maintain a hold on resources or to accumulate capital.

There is also another side to this coin, because improvements in health or nutrition status can bring about a direct improvement in farming. On Muller's figures about guinea worm, referred to earlier, the provision of piped water to villages in western Nigeria would free one quarter of the working population from a disease that incapacitates them for ten weeks or more each year, and that during the busiest period (Muller 1981:128). In agricultural terms, the potential benefit of a health or nutrition intervention can be very great.

(c) Agricultural effects on health and nutrition

Boxes C and D in Figure 1 illustrate the agricultural side of the model: the ways in which agriculture affects health and nutrition. Box D identifies three major kinds of effect, relating to the quantity and quality of food available to a family, the occupational hazards associated with agricultural work and the environmental hazards resulting more generally from agricultural patterns and practices. In food matters, not only food produced should be considered, but also food

purchased and food received as gifts or payments in kind: this provides a broad measure of access to food, comparable to Sen's concept of 'food entitlement' (Sen 1981).

Food output: many farming systems will have the satisfaction of food needs as a prime objective: that is to say, farmers will want to produce enough of a balanced diet for all members of the family over the whole year and in all years. Shortfalls in the quantity, the quality, the timing or the security of food supplies will have a direct effect on the health and nutrition status of the family, probably affecting some (women and children) more than others (men). Conversely, improvements to the pattern of agricultural output may improve health and nutrition status even if total income or value of production does not rise. Hence the interest in farming systems which 'reduce risks and spread both labour demands and flows of food and income from harvests' (Chambers, Longhurst and Pacey 1981:229).

Cash income: may substitute where direct food supply fails and changes in cash income from farming may have a direct positive or negative influence on health and nutrition. There have been arguments on both sides, with some observers stressing the benefits of increased purchasing power and others pointing out that increased income may not lead to better nutrition if food is not available or food choices are poor (Pinstrup-Andersen 1981, Selowsky 1979). Improved income is a worthwhile alternative to improved food supply, provided that food is available for purchase at all times of year, that the terms of trade do not shift against the producer and that access to purchased food is guaranteed to all members of the family.

Payments in kind: changes in agriculture may affect the prevalence or amount of payments in kind, which may in turn affect health and nutrition status. There is evidence that payment in kind diminishes in importance as agriculture becomes more commercially oriented and that this may undermine the food security of the poorest families.

Storage: the characteristics of the farming system, with respect to the seasonality of production and the degree of market involvement, will determine the length of time for which food is stored. Although losses may not be high (Greeley 1982), there will be storage costs and a risk of quality deterioration eg through the growth of mycotoxins on certain crops. These may both have an effect on health and nutrition.

Poisoning and pollution may result from the use of chemicals in agriculture, either directly through ingestion of chemicals or contamination of food, skin or clothing, or indirectly through pollution of water supplies. The damage to health caused by agricultural intensification is now an important area of study and a focus for NGOs in the rural development

area (Bull 1982; Weir and Schapiro 1981). Poisoning is an important cause of increased morbidity (Laurell 1980; Jeyaratnam et al 1982).[4]

Accidents caused by agriculture are little regarded, but potentially important causes of days lost and medical expenses, especially as machinery use intensifies.

Water-borne diseases may increase as a result of irrigation, especially if domestic water sources are contaminated or if standing water results (Bradley 1977).

Livestock related diseases may also increase with agricultural intensification.

The point about all these factors is that changes to farming systems may have an effect on health and nutrition status. As on the other side of the relationship, the change may be for good or bad: although many of the examples given are negative, it remains true that the best way to overcome a health and nutrition problem may be through a change in agriculture. In turn, the removal of a health or nutrition constraint may have a positive effect on agriculture so that a virtuous cycle may be established. All these linkages will not operate to an equal extent for all farmers all the time, but they will be important for some farmers some of the time. It therefore behoves farming systems researchers to be aware of the linkages and of the potential trade-offs between them. The first step is to accumulate data and to this task we now turn.

3. Data collection problems

The kind of data that is required to explore the interdependence between health, nutrition and agriculture falls between sectoral or disciplinary stools. It is very unusual for health and nutrition reports, for example, to include information about agricultural practices. There will be data about the incidence of malnutrition, but this is unlikely to be related to agriculture in a way that corresponds to farming systems classifications. By the same token, agricultural researchers are not accustomed to collecting information about the health and nutrition status of farming populations and the link to agriculture through days lost, cash expenditure or productivity.[5] Nevertheless, a good deal can be achieved by judicious use of secondary sources and modest extensions of existing data collection procedures. The first task is to specify data requirements.

(a) Data requirements

The discussion in Section 2 emphasised that linkages should be assessed separately for different individuals in the family, at different times of year and in a dynamic context. There is a further complicating point to make which is that, in

principle, information is required not only abo t what effects each sector is having on the other but also how and why: this is because intervention requires an understanding of process as well as effect. This may make the data collection problem sound complicated, but there are a number of simplifying procedures available: in particular it may be useful to adopt a step-by-step approach, in which the first task is to establish the magnitude of effects and then select priorities for further study (cf Maxwell 1983). It is important to stress that there will be great variations in the population: not everyone falls ill every year. So the enquiry should be directed to the probability of different events occurring and not just to their impact when they do occur.

Working on this basis, the main priorities for data collection about different farm types might be as follows:

Health and nutrition effects on agriculture

1. Time: What is the probability that different amounts of time will be lost to agriculture because of disease, births or deaths? What are the main differences between men and women? Is there any seasonal pattern? How does this probability distribution of time loss relate to agricultural activities? What is the opportunity cost of time lost by different individuals at different times of the year? Do farmers allow for the possibility of time lost in planning agricultural activities?

2. Productivity: Are there any times of the year when nutrition or disease stress are likely to reduce the productivity of labour used in agriculture? Will this be for men or women or both? What will be the effect on agriculture?

3. Cash: What is the probability that different levels of cash expenditure will be incurred as a result of morbidity, mortality or malnutrition? Is there any seasonal pattern? How will these probabilities affect the availability of cash for agriculture? What is the marginal rate of return to cash lost in this way? Do farmers plan for unexpected medical or other expenses in deciding on the form in which to hold capital or on the pattern of agricultural activities?

4. Food preference: What are the main food preferences? How do they affect the choice of crops grown, the varieties selected, the time of planting and harvesting and the amount produced? Do similar considerations apply to livestock enterprises?

Agricultural effects on health and nutrition

1. Quantity and Quality of food: Is sufficient food produced to guarantee an adequate diet for all the family throughout the year every year? If not, what are the main deficiencies in terms of nutrients (calories, protein, vitamins, minerals), timing (seasonal deficits, a 'hungry season', periodic famines or food shortages) and individual need (eg are women consistently malnourished?). Is cash income large enough and available at the right time to overcome any shortfalls? Is it in fact used for this purpose? Are there any other receipts of food, for example as payment for labour or other services? What is the effect of any shortfalls on health and nutrition status and in turn how does this affect agriculture?

2. Occupational hazards: What is the incidence of accidents or poisoning by agricultural chemicals? Is there any pattern to these as regards age, seasonality or gender? What is the probability of different levels of severity of accidents or poisoning and what contribution is made to the overall pattern of mortality and morbidity? What is the cost in terms of time, satisfaction and cash? How is all this likely to change as agriculture becomes more intensive?

3. Environmental hazards: What are the health risks posed by environmental hazards associated with agriculture, including pollution, especially of water supplies, contamination of food stuffs and diseases spread by irrigation water or livestock? Is there any pattern to these as regards age, seasonality or gender? What is the cost in terms of time, satisfaction and cash? How is all this likely to change as agriculture becomes more intensive?

Clearly, some questions in this checklist require much more detailed information than others, and some require considerable analysis. A probability distribution of time lost by age, gender and month is not easy to prepare; and calculation of the opportunity cost of time lost may require detailed farm system analysis. However, the step-by-step procedure means that priorities can be checked at each stage of data collection and less important items discarded. It is therefore important that data collection methods be flexible.

(b) Data collection

A hierarchy of research methods exists which is commonly used in farming systems research and which is well suited to a step-by-step approach to the study of linkages between health, nutrition and agriculture. The hierarchy is intended to enable progressive deepening of contact with farmers and moves from the relatively cheap and relatively distant or superficial to the relatively more expensive and more detailed

(cf Casley and Lury 1982). There are five main levels and it is worth saying something about each of these:

1. Secondary sources
2. Rapid rural appraisal
3. Surveys
4. Case studies
5. Issue studies.

1. Secondary sources: include government publications, reports by parastatal or non-governmental organisations and the academic literature. Agricultural research stations should normally (though often do not) have collections of agricultural materials relating to areas where they work as well as a system for monitoring new publications. It is likely that agricultural sources will provide some information on many of the items in the checklist, albeit at a higher level of aggregation than would be desirable for farming systems work. Village studies which set agriculture in a social context will be a useful source of information on health and nutrition aspects.[6] In addition, farming systems researchers will find useful information in secondary sources specific to the health and nutrition sectors: nutrition surveys, analysis of hospital admissions, mortality statistics, primary health surveys may all be helpful, although again there will be problems with aggregation. However, in health and nutrition as in agriculture, disaggregated data by area if not by income group may well be available in semi-processed form from statistics departments or other collection agencies. The point, of course, is basic: it is important not to commit resources to primary data collection until all existing information has been collected and carefully reviewed.

2. Rapid rural appraisal: involves a set of techniques based on informal reconnaissance, unstructured interviews and exploratory surveys (Longhurst 1981, Pearce and Jones 1981). It provides farming systems researchers with an opportunity to explore the issue of linkages as part of their interaction with farmers, farmers' families, other rural people, development workers and government officials. Having questions from the checklist 'on the agenda' for this informal work will help to tease out information about the likely size and importance of different factors. However, it is important in working through the agenda to talk not only to farmers, but also to others who will have relevant information. In other words, extending the list of topics may require extending also the list of informants to doctors, nutritionists, public health specialists and community development workers. RRA should provide good information at a general level about seasonal and gender factors, about food preferences and about the main causes of lost time or medical expenditure. However, it is unlikely to provide accurate data about the levels of loss or about

probabilities: more precise methods of data collection will be needed for this.

3. Surveys: single visit surveys are common in farming systems research and focus both on general farm management matters and on specific crop practices (Byerlee, Collinson et al 1981). Adding new questions is likely to be unpopular, because of the existing length and complexity of most questionnaires: but it may be possible to include a few items on priority matters identified during RRA. A one-off survey is limited by the accuracy of recall and should not be relied upon for accurate data about such items as annual medical expenditure; but because it has a randomised statistical design it can provide useful information about the distribution through the population of major events like accidents, poisonings or major illnesses. It may well be the case that medical or nutrition surveys are also being undertaken in the study area: in this case, contact with professionals in these sectors might make it possible to include agricultural questions that would help locate the results within a farming systems classification.

4. Case studies: are a neglected research tool in farming systems research, which make it possible to collect detailed, longitudinal data from a small sample of farms chosen purposively to represent different farm types. Case studies can be carried out without the expense and loss of personal contact associated with large, multiple-visit surveys (Maxwell 1984b). A case study programme involving weekly data collection on labour use and cash flow, both agricultural and non-agricultural, provides an ideal method of exploring many of the health/nutrition/agriculture linkages discussed in the checklist. It is important, however, to locate the case study farms in some kind of probability distribution: if one farmer in a purposive sample of six falls seriously ill, this should not imply that one in six farmers will necessarily fall ill. The statistical inference is invalid. Rather, the opportunity is provided to study process: what happens to a farm and a farm family when a farmer falls seriously ill. The account given below of farming systems research in Bolivia provides an example of the use of the case study method.

5. Issue studies: these are used in farming systems research to follow up particular questions that arise from RRA, surveys or case studies: a particular study of harvest and post-harvest grain losses might be an example (Maxwell 1982). There is scope for special studies of matters relating to health and nutrition linkages, for example studies of diet, of food purchases or of food prices (cf Tripp 1982). The design of these would depend on the particular hypotheses to be tested, but simple studies could be used to illuminate seasonal factors such as food

purchased by different groups at different times. Again, there may be scope for cooperation with parallel studies being carried out in other sectors.

To summarise: the data required are potentially complex. But if priorities can be established and a step-by-step procedure adopted, data collection on linkages can be built in to the normal data collection procedures of farming systems research. What is most important is that researchers should assess the importance of the data collected at each stage and build this into the decision-making process of farming systems research. How this might be done is our next topic.

4. Farming systems research procedures

As indicated in the Introduction, there are reasons to expect that an understanding of the linkages between health, nutrition and agriculture will affect the decisions taken in a farming systems research programme. The nature of the decisions and the likely influence of linkage factors can be explored by returning to the five step fsr procedure described earlier: classification, diagnosis, generation of recommendations, implementation, evaluation. It should again be emphasised that the procedure is continuous and iterative: there is a continual reappraisal of priorities and targets (Maxwell 1984a).

1. Classification: the task here is to classify farms into homogeneous groups, or 'recommendation domains', with similar physical, biological and socioeconomic characteristics (Perrin et al. 1976). Attention is usually focused on soil, rainfall, topography and farm size as the principal factors (Byerlee, Collinson et al. 1980), though other factors may need to be incorporated in order to capture changing social or economic relationships (Maxwell 1984a). Non-agricultural activities should not be excluded; nor should the pattern of social relationships, which will affect agriculture in different ways. It is unlikely that health and nutrition linkages will need to be incorporated directly into the classification, making a difficult process even more so; but it is possible that health and nutrition factors might affect the characteristics of a farming system. In Dominica, for example, banana is said (anecdotally) to be a young man's crop and citrus is said to be an old man's crop: farmers will plant the two together, concentrate on bananas for a few years and then allow the citrus to shade out the banana and shift their (declining) energy to the new crop. The labour power available to banana-dominant and citrus-dominant cropping systems would be different.

2. Diagnosis: at this stage the task is to describe the farming system in sufficient detail such that the limiting factors and opportunities can be identified and targets set for farm improvement. There are many ways in which an understanding of linkages might affect the analysis. In

describing the resources available (land, labour and capital), allowance should be made for the effect of poor health and malnutrition on labour availability and productivity. Male adults might, for example, contribute an average of twenty eight-hour days a month; but there might be two or three months during which they could only manage five or six hours because of poor nutrition, and a further period during which the probability of incapacitating illness for an extended period was high. Similarly, the likelihood of illness might be such that farmers gave a high priority to saving, in cash or in kind (e.g. livestock), so that the availability of capital for farming was reduced or the balance between enterprises affected. In assessing the activities undertaken, allowance should also be made for health and nutrition factors. For example, farmers might pursue a risk minimising strategy in order to guarantee survival (Lipton 1968), or might choose certain 'unprofitable' cropping patterns in order to meet subsistence requirements. Finally, in setting targets for improvement, attention should be paid to health and nutrition targets and not just income targets: to food security, for example, or to reducing occupational hazards.

3. Recommendations: appropriate recommendations are required for different classes of farmers, facing different cost-price relationships, showing different levels of risk aversion and having access to different amounts of cash. They may be available 'off the shelf' or may require research in laboratories, at the research station or in on-farm trials. When recommendations do become available, a check should be made on possible implications for health and nutrition. A particular problem might be an increase in occupational or environmental hazards caused by widespread adoption of chemical technologies, or possibly an increase in water-borne diseases associated with irrigation: when economic analysis of proposed innovations is carried out, these costs should be set against the benefits. In addition external economies and diseconomies should be incorporated: recommendations designed to improve the welfare of particular groups of farmers may affect others, especially through their effect on employment, on food supply or on the environment. However, farmers may need to be given incentives if new technologies which are not profitable in private cost-benefit terms are to be encouraged for social reasons. It might be worth subsidising fertiliser, for example, if this would lead to increases in food production, lower food prices and a lower incidence of malnutrition, with consequent benefits both to consumers and to the government health budget.

4. Implementation: research stations are often involved in support to the implementation of new technologies, for example by producing improved seeds, and usually have a close relation to extension services, even if they are not, as is often the case, under the same management. The importance of possible effects of agricultural change suggests a similar role in relation to health and nutrition: briefing of health and

nutrition agencies, the preparation of special materials on safety, toxicity tests on new chemicals, support to home economics classes and so on.

5. Evaluation: is a continuous process, to monitor the validity of classification and diagnosis, to check on the spread of new technologies and to identify further problems for research. Monitoring of the health and nutrition links should become a part of this process, updating information from the checklist, identifying new constraints or social or environmental changes. For example, the expansion of a system of primary health care might reduce the number of days lost; or the initiation of a network of mother's clubs with nutrition education classes, might reduce the incidence of weanling diarrhoea. These factors are important to the research station and should be known.

It can be seen that at all five stages of the farming systems research procedure, there is potential for improvement if health and nutrition linkages are taken into account. Perhaps the most important conclusion is that farming systems researchers should be sensitive to health and nutrition matters and be prepared to engage in a dialogue with all those who have knowledge about these other sectors, including rural people themselves.

5. A case study: colonist farmers in Santa Cruz, Bolivia

(a) Introduction: the case study is concerned with colonist farmers in the lowland Department of Santa Cruz in Eastern Bolivia. It is based on work carried out from 1978-81, as a contribution to farming systems research in the area by the agricultural economics unit of the Centro de Investigacion Agricola Tropical (CIAT). This work was not principally concerned with studying linkages but enough data was accumulated to suggest that linkages were an important area of study and worth further work: these conclusions have also been reported elsewhere in a preliminary form (Maxwell 1980b). The Santa Cruz case provides a useful illustration of what can be achieved on the linkage front as part of normal farming systems work.

The study area occupies a crescent-shaped piece of land some 160 km long and up to 100 km wide to the north of the city of Santa Cruz, which has been the site of national colonisation over the past 25 years by people from other parts of Bolivia. Some 15,000 families now live in the area and account for 22 per cent of the rural population of the Department. The altitude varies from 100 to 400 m above sea level and the topography is mostly flat. Soils are mostly recent alluvials. The climate may be classified as sub-tropical, with a pronounced dry season (May-October) and mean temperatures of 20-25° C. Rainfall varies from over 2,000 m in the West to under 800 mm in the East with marked variation between years.

Physical infrastructure is poor. The population is heavily biased towards young people by virtue of the fact that colonisation is usually undertaken by young couples. Agriculture is the principal activity; there is no large class of landless labourers, though seasonal migration from other parts of Bolivia is important for the rice harvest (January-April).

The information which follows on farming systems and health and nutrition status was collected from secondary sources and during primary data collection. This included all the methods discussed in Section 3, notably rapid rural appraisal in 1978, a survey of 330 farms in 1979 and an intensive case study programme involving six representative farms in 1980-81. The results of this work have been reported in full elsewhere (Maxwell and Pozo 1981; Maxwell, Stutley and Bojanic 1982).

(b) Farming systems: Agriculture in the area is predominantly slash and burn, with upland rice as the main subsistence and commercial crop. An evolutionary pattern can be discerned in which farmers descend into, and escape from, the 'barbecho' crisis: when virgin forest is exhausted within a 20-50 hectare plot, farmers return to regrowth ("barbecho") with lower yields and higher costs. Incomes fall when the farm enters this barbecho crisis, but "avenues of escape" have been found, including de-stumping, livestock and permanent crops, all of which can yield incomes up to six times higher. This evolution is, however, associated with increasing differences in wealth and income.

Resources: land is generally plentiful, with a mean land-holding in the area of 48 hectares, mostly flat, unfenced and covered in primary forest or secondary regrowth: only 11 per cent of farms have any land de-stumped. The labour force consists typically of one adult male, supplemented by between 50 and 150 days of hired labour. Women do little farm work, except at harvest. There is very little fixed capital and working capital is a constraint. Only 13 per cent of farmers receive credit in any one year, mostly short-term finance for annual crops.

Activities: two-thirds of all farms use less than 20 per cent of the land available in any one year for all crop and pasture activities. Crop activities are concentrated in the wet, summer months (October-March), with small areas sown in the winter, mostly to maize and vegetables. Upland rice is the main crop, followed by pasture, maize, bananas and cassava in that order: together these account for 90 per cent of area sown. There are small areas of other crops. Crop production systems are characterised by low input technologies; fertiliser is not used, but is used by 40 per cent of rice farmers and 24 per cent of maize farmers and pesticide by 15 perr cent of rice farmers and 8 per cent of maize farmers. Hired labour is used principally for harvest, with secondary peaks for land clearing, sowing and weeding. The mean rice

yield is 1,500 kilos per hectare, the mean maize yield is 1,700 kilos per hectare, and the cassava yield 10 tons per hectare. Most crops are produced mainly for subsistence: however, a mean 64 per cent of rice is sold and 27 per cent of maize. Nearly all farms have chickens, 40 per cent have cattle, 40 per cent have pigs. Management levels are low, and pig and poultry enterprises are mostly domestic. Livestock enterprises make a notable contribution to net worth and are thus a form of saving. There is little off-farm employment: 13 per cent of farmers take paid agricultural employment off the farm in any year and 18 per cent earn a non-agricultural income.

Margins: the bulk of the income earned comes from crops rather than livestock or off-farm activities; the mean gross margin (which is the value of production minus variable cash costs) is about $b25,000 ($US1,000) per annum, of which two-thirds comes from crops and one-third from livestock. Incomes are not equally distributed: the richest 25 per cent earn 61 per cent of total income, the poorest 34 per cent only 7 per cent of income.

Classification and scarce resources: 60 per cent of all the farms in the area are in the barbecho crisis, and a further 20 per cent are at an earlier stage of the slash and burn cycle, which has not yet reached a crisis point. Thus, only 20 per cent of farms have begun to escape from the barbecho crisis: half of these have begun to de-stump and mechanise, most of the rest have begun to specialise in livestock. Clearly, land is generally plentiful relative to labour and capital in the area. Working capital to hire labour is particularly scarce and cash flow management becomes a major problem as farms try to expand.

(c) Health and nutrition data: the few available studies agree in indicating high levels of mortality, morbidity and malnutrition in the study area.

A study carried out by USAID in 1975 reached the conclusion that 'the level of health of the population of Bolivia is possibly one of the lowest in Latin America', and noted that 'malnutrition in tropical areas is probably more of a problem than in other parts of Bolivia, in spite of the fact that these are agricultural areas' (USAID 1975). This observation applies especially to children, and very high levels of mortality and morbidity have been observed in the study area: in a study carried out by the Rural Health Project of Montero, an infant mortality rate of 114 per 1,000 live births was observed (Frerichs 1979) and according to De Muynck 'it is possible to affirm that (in the Yapacani area) of every 10 newly born children, only 7 will reach the age of 1 year and only 5 the age of 10 years' (De Muynck 1976).

As far as malnutrition is concerned, various studies have reported that more than 30 per cent of the children in the

rural areas of Santa Cruz suffer from malnutrition. In a study in 1971, 25 per cent of the children between 13 and 24 months of age and 33 per cent of those from 25 to 26 months of age suffered from second or third degree malnutrition on the Gomez scale. (Programa de Salud de Montero 1972). In a later study, Frerichs (1979) noted that 17 per cent of the children from 0 to 5 years had a low weight for age and concluded that 'a significant percentage of the children show the effect of prolonged malnutrition'.

It is difficult to estimate the costs associated with these figures, but available data on days lost and medical expenses in Santa Cruz suggest that they may be high. In a survey of 10 colonies in the north of Santa Cruz, for example, Craber noted that 43 per cent of the colonists lost more than 30 days of work during the year and 27 per cent more than 45 days because of illness (Methodist Church in Bolivia 1972).

Frerichs (1979) presents data that suggest that the average number of days lost per year reached 11 for men of 15-24 years and 22 for men 25-44 years. If we assume that there are 250 days available for work per year, these figures represent between 4 and 9 per cent of the total available time, figures consistent with national estimates of 5-10 per cent of time lost because of sickness (Zuvekas 1977).

Apart from the cost in work lost, it is necessary to take into account the cost of medical treatment. Frerichs (1979) calculates an average of $b7725 ($US 309) per family per annum, though notes that this may be overestimated, which seems certain given low incomes in the area. Nevertheless, it is clear that medical costs may absorb an important part of the cash income received by typical families in the zone.

Finally, it should be noted that medical facilities in the area are rudimentary. Health posts are widely scattered and poorly equipped. There are, however, primary health care projects in some areas and a network of mothers' clubs distributes a certain amount of food aid.

(d) Linkages between health, nutrition and agriculture

The data presented on farm systems and on the health and nutrition data enable some inferences to be made about the linkages between health, nutrition and agriculture. It is worth setting these out and illustrating the points made with supplementary data from the case study programme. The caution against aggregating or averaging case study data should be repeated: this was a purposive sample to represent different farm types and so is not in itself representative of the population. For a summary of farm characteristics, see the Appendix.

Health and nutrition effects on agriculture. First, it is clear that health and nutrition constrains agriculture in most

of the ways suggested earlier. Illness costs time: the aggregate figures quoted above suggest up to 10 per cent on average of the time available for agriculture and in some cases much more. The case study figures, summarised in Table 1, confirm this picture and underline the risk associated with illness. Of the six farmers studied only one was not ill at all during the study year; four others lost between 3 and 20 days, but one lost as many as 128 days, more than he spent on agriculture. Furthermore, many of the farmers lost additional time (aggregated in column 3 ('other')), because their wives or children were ill and required care. Most of the days lost were incurred during the main agricultural season from October to May.

Table 1
Use of farmer's time
Case-study farmers
1 October 1980-30 September 1981

Farmer	No. of days spent on			
	Agriculture	Illness	Other[1]	Total
A	211	20	134	365
B	240	18	107	365
C	253	9	103	365
D	168	-	197	365
E	121	128	116	365
F	240	3	122	365

Source: Maxwell, Stutley and Bojanic, 1982, Table 3
Notes: 1. includes domestic, leisure, community work and off-farm activities.

The cost of these days lost can be estimated in various ways. At the average daily wage of about $b100, 20 days illness would have cost Farmer A $2,000 or nearly 10 per cent of his farm profit for the year. However, the average return to farmers' labour was higher than $b 100, $b 103 in the case of Farmer A, but up to $b 140 in the case of Farmer C and $b 364 for Farmer F: this would increase the cost substantially. Furthermore, illness tended to occur at busy times when the opportunity cost of labour was very high so that the loss might be even higher. Farmer E was ruined by his illness, going heavily into debt. It seems that even average illness is very expensive, while serious illness is catastrophic.

Illness also costs money. The figures quoted earlier may not be reliable, but Table 2 gives figures for the case study farmers and compares this with other items of expenditure. For only two of the farmers does medical expenditure exceed 10 per cent of total personal expenditure on food, clothing, housing and miscellaneous domestic expenditure. But in four

cases out of six, medical expenses are more than total expenditure on agricultural inputs. This figure should be assessed in the context of a system where the single most scarce resource is working capital and where the average return to cash is over 100 per cent. In most cases, farm profit could have been increased by 10 per cent or more if the amount spent on medical expenses had instead been invested in agriculture.

As in the case of time, the possibility of calamity is always present. A case in point is Farmer A who lost a child just before the initiation of this study. The expense of unsuccessful medical treatment and subsequent funeral seriously depleted his working capital for the year and limited his ability to hire labour and expand sown area.

Table 2

Summary of cash expenditure
Case study farmers
1 October 1980 - 30 September 1981

Farmer	Personal expenditure	Of which medical	Other expend.[2]	Of which inputs	Total
	($b)[1]	($b)	($b)	($b)	($b)
A	19713	682	9230	310	28943
B	14997	1065	22773	230	37770
C	20565	30	20970	730	41535
D	33997	3477	58292	1450	92289
E	28816	11998	56121	9701	84937
F	35252	1370	214603	6870	249855

Source: Maxwell, Stutley and Bojanic (1982) Table 4.
Notes: 1. $US1 = $b 25.
2. 'Other' expenditure includes all productive items, such as labour, inputs, contract hire and credit repayments. In accounting terms it is equivalent to payments in the trading net cash flow and the capital net cash flow.

No information was available from this study on reduced productivity. Questions to farmers about nutritional constraints on agriculture revealed no major problems: as the data above suggest, these are farmers with a substantial marketed surplus (which does not necessarily mean a large income), who have no strong reason to grow particular crops other than subsistence requirements of rice and maize and small plots of vegetables.

Agricultural effects on health and nutrition. This does not mean that agricultural activities had no effect on health and

nutrition status, and, turning to the other side of the model in figure 1, several observations are in order. In the first place, food security is clearly inadequate as the aggregate nutrition data quoted above might suggest. There are two main reasons for this. The first is that food production is somewhat limited in nutritional content and heavily seasonal in its time profile. The major outputs are rice and maize with minor vegetable production, and the majority of agricultural activity is concentrated in the rainy season. There is a shortage generally of green, leafy vegetables and it is possible that protein also may be short at some times of the year. Only 0.6 per cent of the area cultivated in the colonisation zone was sown to beans in 1978-79 and only 0.4 per cent to groundnuts (Maxwell and Pozo, 1981). Animal protein is, however, more readily available, as the figures quoted earlier for livestock holdings suggest. The seasonality of food production poses clear problems of food supply for three to four months before the harvest.

Shortfalls in food supply would not matter if cash income were sufficient to compensate, but cash incomes are low and also highly seasonal. Although personal expenditure reported in Table 2 may seem high by comparison with small farmers in other countries (US$ 600-1410), all the farmers were severely constrained by cash and all had lower cash savings at the end of the year than at the beginning. Furthermore, they were all particularly short of cash during the agricultural season: only the largest farmer had a cash income during more than six of the twelve months in the year. Purchases of macaroni, oil, meat, salt, sugar and coffee were made all year round, but were more limited during the rainy season when prices also rose because of the difficulty of communication. There was no dramatic 'hungry season'. Nevertheless, although no detailed nutrition data were collected from case study farmers, it can be concluded that food insecurity was a problem and that it probably caused health and nutrition problems.

Agriculture also had an effect on health and nutrition through occupational hazards. Accidents were a major cause of time lost, often associated with tree felling in the forest; and chemical poisoning also caused problems, being the second most important cause of death in one colonisation area (K. Graber, personal communication). Environmental hazards were fewer in this area, which benefited from low population density, had no irrigation and little intensive livestock.

Clearly, there are limitations to this data. Food consumption and nutrition data are not available and information about the work levels and health status of women is particularly weak. But enough evidence is available to suggest that for this group of farmers the cycle of interdependence identified earlier in the paper is an important part of their lives. What, then, are the implication for farming systems research?

(e) Implications for farming systems research

In the first place, the analysis of linkages contributes at the diagnostic stage to an understanding of the characteristics of the farm system. Both the availability and productivity of labour and cash are reduced by poor health and nutrition, particularly during the main agricultural season. Although not all farm families will suffer from illness every year, most will, and most will expect to: allowance should be made for this. For example, the number of days available for agricultural work by the adult male does not exceed 20 per month and illness is one cause of this.

Because farmers know that they or their families are likely to be ill and run a risk of catastrophic illness, they are likely to try to conserve capital and build up a reserve in cash or kind: this may account for interest in livestock, especially pigs, as a store of wealth; also in land as a long-term investment. It may also help to explain why farmers require a high rate of return to capital invested in agriculture. There are also more practical results: the existence of a seasonal food and cash shortage between January and April explains the interest in early-maturing 90-day rice varieties, which provide early relief of these shortages despite having a lower yield than normal 120-day varieties. It is probably also the case that the staggered harvest associated with different varieties helps to reduce the risk of loss if the farmer falls ill at a crucial harvest peak.

All this has implications for the objectives of research and the design of inproved farm systems. At least five specific responses might be suggested to the linkage analysis:

1. Produce more: greater wealth and income are the greatest security against illness and the best way to reduce malnutrition and increase food security. Since marginal income elasticities of demand for food are certainly high, this may be a cost-effective approach. Agricultural intensification does not always offer all farms a way to improved living standards, but in this particular case there is a high potential benefit to research on avenues of escape from the barbecho crisis: mechanisation, livestock and permanent crops being the main alternatives (Maxwell 1980a).

2. Produce a more balanced diet: to the extent that iron, vitamin A and possibly protein are in short supply, researchers might look at new crops or encourage the extension service to do so. Given the plentiful supply of land, this could probably be done quite easily on a domestic scale without sacrificing other crop or livestock enterprises.

3. Improve seasonal distribution: a great contribution could be made to the overall health and stability of the farm system, by reducing the seasonal stresses in cash and food supply. An example is research on quicker-maturing varieties

of winter maize that would yield cash and food at the beginning of the rainy season and provide a store to last through until the summer harvest. Research on 90 day rice that improved yield without sacrificing early maturation would also be helpful, as would work on complementary enterprises like bananas or livestock that could provide nutrition and cash income during otherwise deficit periods. Farmers would probably be prepared to sacrifice some income in order to secure better seasonal distribution.

4. Improve security: farming systems research should always take account of the need to build reserves (what Robert Chambers calls 'buffers') against the possibility of disease. Probably little can be done to guard against the kind of catastrophe suffered by Farmer E, but a farm family will be better protected if it has: more cash; more capital that can be liquidated quickly (livestock or trees); more food in store; spare land; or stronger social networks. Of course, such buffers may be difficult for families on the margin of existence, but they are feasible in this situation and should be an objective of farming systems work even at the cost of immediate income. The existence of buffers would probably reduce risk aversion in the medium term and increase the rate of adoption of income-enhancing innovations (Lipton 1979).

5. Reduce occupational hazards: the prevalence of accidents and of chemical poisoning in the present system might strengthen the case for system changes. Thus a move out of slash and burn into more stable agriculture would have additional attractions over and above immediate economic advantages. So might the adoption of biological control to reduce chemical use. Alternatively, better education might be considered a priority and attention might be devoted to producing extension pamphlets designed to reduce occupational accidents.

Of course, not all these responses are consistent with each other and there will in practice be some trade-offs to be considered. For example, to what extent should an income objective be sacrificed to seasonal or security objectives? There is no clear way to resolve such trade-offs, short of consulting farmers and involving them in the decision-making process. What is important, however, is that there should be such a process and that choices should be made explicit.

(f) Conclusion

The case study is incomplete in certain respects. The data base is uneven in quality and the study is speculative in the sense of demonstrating what might be done rather than reporting what was actually done to modify the research programme. For this reason it does not deal with the difficult institutional problems of allocating research resources and monitoring progress on health and nutrition linkages. Nevertheless, two points should be clear: first,

health, nutrition and agriculture are indeed interdependent, sometimes in unexpected ways. Secondly, this interdependence has important implications for the content of a farming systems research programme that is directed to improving the welfare of farm families.

6. Final remarks

This paper has approached the problem of linkages from a farming systems perspective. In doing so, it has taken a deliberately microcosmic view and focused on linkages as they affect individual farm families in their productive activities. There are dangers in doing this, as there are indeed in farming systems research generally, and two of these deserve mention. The first is that individual farm families or farming systems tend to be seen as static and independent. This is clearly not the case, and farm systems should not be divorced from their social and economic setting, which is constantly changing (Maxwell 1984a).

The second point is related to the first and has to do with the relationship between the immediate farming context and the wider world. Health and nutrition status does not depend purely on agricultural activity but also on a host of other factors (FAO 1982). In particular, macroeconomic considerations may have a great influence on the linkages between health, nutrition and agriculture. Changes in input or output prices brought about by government intervention, for example, or changes in world markets, may affect income and nutrition status much more quickly, for good or ill, than adjustments to farming systems.

However, neither of these points invalidates the basic thesis of the paper, that specific linkages exist and that they matter to farming system researchers. Indeed, a stronger conclusion is possible: it is only through the use of a holistic and multidisciplinary research procedure, such as farming systems research, that linkages can successfully be explored. The kind of analysis described here would not be possible for a research system that focused only on specific crops, even if such work was carried out within a nominally holistic framework. The existence of linkages therefore provides another strong argument for farming systems research.

There is, however, a great deal more to be done. There is a shortage of case studies to illustrate the nature and dimension of the linkages in different farming systems, and little experience in incorporating understanding of the linkages into the decision-making of agricultural research. The task of filling these gaps is one for researchers in research stations and outside; but also one for research managers and policy makers. Above all, the need is for cooperation between professionals in different sectors, who

must overcome professional and institutional bias (Chambers 1983) and work with rural people to establish their own linkages.

NOTES

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2. See, however, Berg et al. (1973), Berg (1981). See also the discussion on external economies in Section 4, and Timmer, Falcon and Pearson (1983).

3. This does not exclude non-agricultural activities undertaken by farming families and is consistent with a more general approach to 'household systems'. See the discussion in Section 4.

4. Jeyaratnam et al (1982) report that in Sri Lanka approximately 13,000 patients are admitted to hospital each year for pesticide poisoning (79 cases/100,000 population) and that of these 1,000 die. Suicide attempts account for 73% of the total and occupational or accidental poisoning for 25%.

5. For sample checklists used in data collection for farming systems research, see, for example, Collinson (1981), Shaner et al. (1981).

6. See, for example, Schofield (1979) for an overview of nutrition data from village studies.

REFERENCES

Berg, A., 1981, 'Malnourished People: A Policy View', Poverty and Basic Needs Series, The World Bank, Washington DC, June

Berg, A., N.S. Scrimshaw, and D.L. Call (eds), 1973, Nutrition, National Development and Planning, Massachusetts Institute of Technology Press, Cambridge, MA.

Bradley, David J., 1977, 'The health implications of irrigation schemes and man-made lakes in tropical environments' in R. Feachem, M. McGarry and M. Mara (eds), Water, Wastes and Health in Hot Climates, John Wiley, Chichester

Bull, D., 1982, A Growing Problem: Pesticides and the Third World Poor, OXFAM, Oxford

Byerlee, D., M. Collinson et al, 1980, Planning Technologies Appropriate to Farmers: Concepts and Procedures, CIMMYT, Mexico

Casley, D.J. and D. A. Lury, 1982, Monitoring and Evaluation of Agriculture and Rural Development Projects, A World Bank Publication, The Johns Hopkins University Press, Baltimore

Chambers, R., 1983, Rural Development: Putting the Last First, Longman Press, Harlow

Chambers, R., R. Longhurst and A. Pacey (eds), 1981, Seasonal Dimensions to Rural Poverty, Frances Pinter, London

Collinson, M., 1981, 'A low-cost approach to understanding small farmers', Agricultural Administration, vol 8, no 6, November.

Crook, N. and T. Dyson, 1981, 'Data on Seasonality of Births and Deaths' in Robert Chambers, Richard Longhurst and Arnold Pacey (eds), Seasonal Dimensions to Rural Poverty, Frances Pinter, London

De Janvry, A., 1981, The Agrarian Question and Reformism in Latin America, Johns Hopkins University Press, Baltimore and London

De Muynck, A., 1976, 'Situacion de Salud de la Colonia de Yapacani', Boletin Informativo del Cenetrop, vol 11, no 7 (Santa Cruz)

FAO, 1982, Integrating Nutrition into Agricultural and Rural Development Projects, Nutrition in Agriculture No.1, FAO, Rome

Frerichs, R.R., 1979, Health and Illness in Rural Bolivia: a Household Survey. Montero Region, Bolivia 1977, University of California, Los Angeles

Goodman D. and M. Redclift, 1981, From Peasant to Proletarian, Basil Blackwell, Oxford

Greeley, M., 1982, 'Farm level post-harvest food losses: the myth of the soft third option', Bulletin vol 13, no 3, IDS, Sussex

Jeyaratnam, J. et al, 1982, Bull. of the World Health Organisation vol 60, no 4, 615-19

Laurell, A.C., 1980, 'Mortality and working conditions in agriculture in developing countries' in S.H. Preston (ed), Biological and Social Aspects of Mortality and the Length of Life, Proc. of a seminar, Fiuggi, Italy, 13-16 May 1980. Inst. for the Study of Population

Lipton, M., 1968, 'Theory of the Optimizing Peasant', Journal of Development Studies vol 4, no 3, April

——— 1979, 'Agricultural risk, rural credit and the inefficiency of inequality' in J.A. Roumasset, J-M. Boussard and J. Singh, Risk, Uncertainty and Agricultural Development, ADC, New York

Longhurst, R. (ed) 1981, 'Rapid Rural Appraisal: Social Structure and Rural Economy', Bulletin vol 12, no 4, IDS, Sussex

Maxwell, S.J., 1980a, 'Marginalized colonists to the north of Santa Cruz: avenues of escape from the barbecho crisis' in F. Barbira-Scazzocchio (ed), Land, People and Planning in Contemporary Amazonia, Occasional Publication No 3, Centre of Latin American Studies, Cambridge University

——— 1980b, 'Salud, nutricion y agricultura: el caso de las colonias de Santa Cruz, Bolivia', Boletin del Centrop vol VI

——— 1982, 'Harvest and post-harvest issues in farming systems research', Bulletin vol 13, no 3, IDS, Sussex

——— 1983, 'From Understudy to Leading Star: The Future Role of Impact Assessment in Food Aid Programmes', Bulletin vol 14 no 2, IDS, Sussex

——— 1984a, 'Farming Systems Research: Hitting a Moving Target', IDS Discussion Paper, Sussex, (forthcoming).

———————— 1984b, The role of case studies in farming systems research, IDS Discussion Paper, Sussex, (forthcoming)

———————— and M. Pozo, 1981, 'Farm Systems in the colonization crescent of Santa Cruz, Bolivia: results of a survey', Working Paper No 22, CIAT, Santa Cruz, Bolivia

———————— C. Stutley and A. Bojanic, 1982, 'Report on a case study programme in San Pedro', Working Paper No 27 CIAT, Santa Cruz, Bolivia, July

Methodist Church in Bolivia. Rural Work Committee Eastern District 1972, Agricultural Life in the Colonies: an Economic Study of 10 Colonies North of Santa Cruz, Bolivia, Santa Cruz

Muller, R., 1981, 'Guinea-Worm Infection', in Robert Chambers, Richard Longhurst and Arnold Pacey (eds), Seasonal Dimensions to Rural Poverty, Frances Pinter, London

Norman, D.W., 1980, 'The Farming Systems Approach: Relevancy for the Small Farmer', MSU Rural Development Paper 5, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan

Palmer, I., 1981, 'Seasonal Dimensions of Women's Roles' in Robert Chambers, Richard Longhurst and Arnold Pacey (eds), Seasonal Dimensions to Rural Poverty, Frances Pinter, London

Payne, P.R., 1981, Dependence of Nutrition on Rural Development, mimeo, GTZ seminar on Nutrition and Rural Development Planning November 16-20

Pearce, J. and G.E. Jones (eds), 1981, 'Rapid Rural Appraisal - special issue', Agricultural Administration vol 8, no 6, November

Perrin, R.K., D.L.Winkelmann, E.R.Moscardi and J.R.Anderson, 1976, 'From Agronomic Data to Farmer Recommendations: An Economics Training Manual', Information Bulletin 27, CIMMYT, Mexico

Pinstrup-Anderson, P., 1981, 'Nutritional Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches', World Bank Staff Working Paper 456, World Bank, Washington DC, May

Programa de Salud de Montero, 1972, Resumen del Programa de Salud en Montero y Zona Norte 1965-72, Montero

Ruthenberg, H., 1980, Farming Systems in the Tropics, 3rd edition, The Clarendon Press, Oxford

Schofield, S., 1979, Development and the Problems of Village Nutrition, IDS, Sussex and Croom Helm, London

Scrimshaw, N.S., C.E. Taylor and J.E. Gordon, 1968, 'Interaction of Nutrition and Infection,' WHO Monograph Series No.57 WHO, Geneva

Selowsky, M., 1979, 'Balancing trickle-down and basic needs strategies: income distribution issues in large, middle-income countries with special reference to Latin America', Staff Working Paper No.335, World Bank, Washington D.C.

Sen, A., 1981, Poverty and Famines, The Clarendon Press, Oxford

Shaner, W.W., P.F. Philipp and W.R. Schmehl, 1982, Farming Systems Research and Development: Guidelines for Developing Countries, Prepared for USAID by the Consortium for International Development (CID), International Development Series, Westview Press, Boulder, Colorado

Timmer, C.P., W.P. Falcon and S.R. Pearson, 1983, Food Policy Analysis, published for the World Bank by The Johns Hopkins University Press, Baltimore

Tripp, R., 1982, 'Including dietary concerns in on-farm research: An example from Imbabura, Ecuador', Economics Program Working Paper, CIMMYT, Mexico

USAID, 1975, Bolivia: Health Sector Assessment, La Paz, January

Weir, D. and M. Schapiro, 1981, Circle of Poison, Institute for Food and Development Policy

Zuvekas, C., 1977, 'Unemployment and Underemployment in Bolivian Agriculture: A Critical Survey of the Literature', General Working Document No.3, Bolivia Series, USAID

Appendix

Case Study Programme, 1 October 1980 - 30 September 1981, Summary of Results

	A Basic barbecho	B Barbecho diver-sified	C Diver-sified livestock	D Small scale de-stumped	E Small scale de-stumped	F Diver-sified de-stumped
1. RESOURCES						
1.1 Land (has) Total	30	48	60	30	30	60
destumped		-	-	7	5	17
1.2 Labour (no.)	1	1	1	1	1	1
1.3 Capital (no.)						
lorry		-	-	-	-	0.5
tractor	-	-	-	-	-	0.5
spray	-	-	-	-	1	1
1.4 Livestock (A.U.)						
cattle	-	2.4	9.4	-	-	3.4
pigs		2.5	10.5	3.5	12	-
1.5 Net worth ($b)	94900	162850	277750	105500	92600	291400
2. ACTIVITIES (1980-81)						
2.1 Total area used (ha)	3.0	7.0	12.5	9.9	8.8	26.0
of which annual crops	3.0	4.0	4.6	8.9	8.0	17.0
2.2 Crops sown (ha)						
* rice	2.5	3.0	3.8	4.3	3.0	6.0
maize	3.0	3.0	1.7	4.5	3.9	12.5
total	6.0	6.0	5.9	8.8	8.0	18.5
2.3 Bananas (ha)	m	1.5	-	1.0	-	5.0
2.4 Hired labour (no.)	55	208	154	218	139	350
2.5 Total cash exp. ($b)	8840	23443	20770	46257	50641	105343
3. INCOMES ($b)						
Gross margin crops	17910	12760	6560	13591	1320	20213
Gross margin livestock	5010	16425	29825	6400	4804	20000
Farm profit	21720	27135	35485	20148	5204	87725

Source: Maxwell, Stutley, Bojanic (1982)

Note: $US 1 = $b25
m = minor

*of which	A	B	C	D	E	F
(a) summer rice	2.5	3.0	3.8	4.3	3.0	6.0
maize	1.0	-	-	2.5	-	10.0
(b) winter maize	2.0	3.0	1.7	2.0	3.9	2.5
(c) other	0.5	-	0.4	-	1.1	-
	6.0	6.0	5.9	8.8	8.0	18.5