MODELLING POOR FARM-HOUSEHOLD LIVELIHOODS IN ZIMBABWE:

LESSONS FOR PRO-POOR POLICY

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EXECUTIVE SUMMARY

This paper describes part of a study undertaken to investigate possible impacts of alternative policy instruments seeking to promote pro-poor agricultural growth in poor rural economies. We report on the development and application of a set of non-linear programming models of farm/households in communal areas in Zimbabwe, with separate modelling of high and low potential areas. The paper begins with an introduction to the objectives of the study and the main features of agriculture in Zimbabwean communal areas in. We then describe the development of a set of programming models of major farm/household types. The models effectively describe ways in which different household types respond in different ways to changes in crop and labour markets. The household models are then aggregated to provide an analysis of the structure of the informal rural economy in the high and low potential areas. The paper discusses the methodology developed, the main results obtained, and strengths and weaknesses of the methodology as a tool for policy analysis. The following methodological, analytical and policy points are highlighted in the paper:

- Adaptation of a basic methodology and model structure developed for analysis of Malawian farm/household livelihoods was broadly successful, though still demanding significant analytical resources in data assimilation and model modification. There is potential for further standardisation and development of the approach to extend the depth and scope of analysis in Zimbabwe and elsewhere.
- A key issue raised in model development and in subsequent analysis concerned the structure and operation of rural labour markets. Divergence between off-farm wage rates and returns to farm labour highlights the importance of social relations in determining access to and returns from off-farm employment, but despite its importance to the welfare of the poor, little information is available on this topic.
- Increases in maize prices provide direct benefits to better off households, and in higher potential areas poorer households may benefit from second round effects resulting from increased on farm labour demand and a general stimulus to the economy, off setting welfare losses from higher food prices. In lower potential areas, however, the number of households benefiting from increased maize prices is very limited, as is the extent of their benefit and consequently second round gains to the poor are likely to be very limited and will de dominated by welfare losses from higher food prices.
- Higher wages lead to direct, first round increases in incomes for the able bodied poor, as well as second round effects through the labour market (as a result of production and, more important, consumption linkages) and hence to reductions in poverty.
- Increases in crop prices offers immediate and fairly broadly distributed direct income benefits. However, the ability of poorer households to respond to and gain from higher prices by expanding production is constrained by their limited access to capital and to land. Unless these supply response constraints are addressed, benefits to the poor are largely restricted to second round effects from higher labour demand.
- In both high and low potential areas both own-farm and non-farm activities are very important to the livelihoods of the poor. While non-own-farm activities and income accounting for around 70% of most poorer households' incomes, smallholder agriculture is still the most important sector underpinning the rural economy, with remittances also of major importance, particularly in the lower potential areas. Smallholder agriculture plays a critical role in promoting household food security and in directly and indirectly tightening labour markets (holding up wages and employment opportunities).
- In higher agricultural potential areas where there is a greater likelihood of second round wage effects from agricultural growth, promotion of institutional and labour demanding technology changes appears to be a viable poverty reduction strategy. In lower potential areas achieving such change is more challenging and will have more limited impact. In such areas agricultural development can and should play an important role in improving food security, but significant agricultural growth is unlikely. It is however difficult to identify alternative pro-poor growth drivers within the rural economy: significant

pro-poor growth is more likely to be achieved by policies that stimulate labour demanding growth elsewhere in the national economy and improve access to national and international migrant labour opportunities.

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1 Introduction

This paper describes work undertaken as part of a wider project investigating alternative institutional and economic policies to promote pro-poor agricultural growth[1]. Earlier outputs from the project have reviewed progress in agricultural development and poverty reduction over the last 50 years, the policies associated with success and failure, and the challenges facing agricultural economies that have yet to raise their productivity as the first part of an economic transformation out of an agrarian economy (Dorward *et al.* forthcoming), and have examined these issues in relation to specific countries selected for case studies (Dorward and Kydd 2002; Poulton *et al.* 2002; Smith and Urey 2002). In this paper we take a first step towards addressing some of the questions raised in these papers by developing a set of models to describe major features of poor rural livelihoods in the communal areas of Zimbabwe (based on 1996 data). We then use these models to investigate the effects of different shocks and policy changes on the livelihood strategies of, and poverty incidence among, different types of household. In this our primary focus is not to model and analyse Zimbabwean rural livelihoods in order to develop policy recommendations for Zimbabwe (although this would be a useful output from the work) but to use these models for developing more general understanding of processes of pro-poor growth in a poor rural economy.

The paper is structured in four sections. Following this introduction we provide a brief description of smallholder agriculture in Zimbabwe's communal areas and identify critical issues facing policy with respect to these areas[2]. This sets the agenda for the development and application of farm/household models: we describe their structure, scope, and validation before subjecting them to a variety of different shocks and scenarios. These are chosen to illustrate the capacity of the models to shed light on the effects of alternative policy regimes on heterogeneous communal farm households in Zimbabwe. However, detailed analysis of specific policy options is not attempted in this paper. The final section draws together the main conclusions.

2 Background and Policy Issues[3]

Poverty in Zimbabwe is primarily a rural phenomenon, although urban poverty rose alarmingly in the 1990s. In rural areas, poverty has historically been linked to the highly skewed distribution of land, with the majority of rural residents consigned by colonial governments to live in areas of low agricultural potential. However, the percentage of the population classed as poor showed a particular increase in the 1990s. Using the poverty line adopted by the International Development Targets, i.e. the number of people with incomes under US$1 per day, DFID 1999 estimate that there were around five million poor people in Zimbabwe (i.e. around 40% of the total population). They note that the high level of inequality in Zimbabwe produces much higher poverty figures than might be expected given average income levels for the country as a whole.

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[1] Institutions and Economic Policies for Pro-Poor Agricultural Growth. Project R7989 funded by the Social Science Research Committee, Department of International Development.
(see www.wye.ic.ac.uk/AgEcon/ADU/projects/ppag)

[2] Our analysis relates to conditions up to 2000: we do not take into account the profound and rapid changes that have occurred from 2001 to 2003.

[3] This section draws heavily from Poulton, Davies *et al.* 2002

Poverty is most highly concentrated in the so-called communal and resettlement areas, and the incidence of poverty also increases as one moves into the lower potential agro-ecological zones (natural regions IV and V, according to the local classification[4]). More rural people live in natural region IV than in any other natural region, so consequently the largest number of rural poor is found in this region.

According to surveys conducted in the 1990s, poor households tended to be characterised by the following features: large household size, high dependency ratios, older or very young household heads, small land holding, and low levels of education. The activities the household engaged in were also important. Poor households tended to be food crop farmers, migrant workers in communal areas or workers on commercial farms. Households with diversified income sources (especially having one or more members in wage employment) tended to experience less poverty and to be less vulnerable. Inequality is high even within the communal areas themselves. Livestock holdings are a key indicator of wealth (and a critical production asset) amongst smallholder households.

The incidence and impact of AIDS escalated dramatically in Zimbabwe in the 1990s. World Health Organisation 2000 estimate that, at the end of 1999, around 1.4 million adults (i.e. 25% of the population aged 15-49) were HIV-positive, along with 56,000 children. There is, however, considerable variability between sites. Economically, rural households in which a member(s) contracts AIDS suffer both from loss of labour and also from reduced cash availability due to increased medical expenditures.

Agriculture is a vital sector of the Zimbabwean economy providing employment and livelihoods for 70% of the population. In the 1990s, depending on annual weather conditions, the sector also contributed between 40% and 50% of total export revenues. Agricultural performance varies dramatically year-to-year depending on the rainfall and these vagaries impact more powerfully on the lower potential areas (and consequently more on communal farmers than on commercial ones). After 1980 the general trend in production in both the commercial and the communal areas was upwards, with strong early gains following the end of the liberation war. However, since 1985-6 agricultural production growth has not kept pace with population growth in the communal and resettlement areas. This provides an important part of the explanation for the disappointing story on poverty alleviation.

The poor performance of smallholder agriculture in reducing poverty has prompted a number of suggestions as to priority actions to foster growth in communal areas, including greater emphasis on research, extension and input supply, further trade liberalization and a variety of land reform proposals. The latter have largely been overtaken by events on the ground since 2000[5]. The poor road infrastructure and underdeveloped nature of transport services within Zimbabwe's communal areas also remains a key issue Whilst the situation may have eased somewhat in the 1990s (following foreign exchange constraints in the late 1980s that made imported vehicles and spare parts hard to come by), some of these gains are likely to be eroded by the current economic crisis. In more stable times, investment in this area would still seem to offer a good opportunity both to

[4] Land in Zimbabwe has been classified into five natural regions based on rainfall and type of agriculture. Communal farmers are not well represented in the higher potential regions that were (until recently) dominated by commercial agriculture.

[5] We have not yet developed farm household models for resettlement households, although current models could fairly readily be adapted to represent such households. Meanwhile, the nature of the resettlement exercise in practice means that much less pressure has been taken off land in communal areas than might otherwise have been the case.

stimulate agricultural production and to facilitate the mobility that allows other, non-agricultural activity to flourish.

3 Development and Application of a Farm/Household Model of Rural Livelihoods

3.1 Farm/household model structure

The structure of a Malawian farm-household model (Dorward 2003) was used as a base from which to develop the Zimbabwe model. The model was formulated as a non-linear programming model with the following structure[6]:

$$MaxE(U) = \sum_{s} P_s \prod_{j*m} (C_{jm} - \gamma_{jm})^{\beta_{jm}} \quad (1)$$

such that

for m = 1 to 2

$$-t_{jm} + t_{j(m+1)} + \sum_{ij} e_{ijm} x_i + C_{jm} \leq 0 \quad (2)$$

for m = 3 to 4

$$-t_{jms} + t_{j(m+1)s} + \sum_{ij} e_{ijms} x_{is} + C_{jms} \leq B_{jm} \quad (3)$$

for m = 4

$$-t_{j(m+1)s} = t_{j(m=1)} \quad (4)$$

where

- m are periods within a year: m = 1 describes the 'cropping period' (November to January); m = 2 describes the 'pre-harvest period' (February and March) ; m = 3 describes the 'harvest period' (April to June); and m = 4 describes the 'post harvest period' (July to October).
- s are alternative market conditions as regards end of season maize prices (in periods m= 3 and m= 4)
- P_s are subjective probabilities of alternative market conditions s
- C_{jm} represent total consumption of commodity/ resource j in period m
- γ_{jm} are minimum consumption requirements for commodity/ resource j in period m
- β_{jm} are the marginal propensities to consume commodity/ resource j in period m

[6] The description of the model draws heavily on Dorward 2003.

t_{jms} represent transfers of commodity/ resource *j* from period *m* to period *m+1* in market condition *s*

e_{ijms} are technical and price coefficients of use/ production of resource / commodity *j* by activity x_{is} in period *m* under market condition *s*

x_{is} are activities undertaken by the household. These include cropping activities, buying and selling of stocks and labour, and stock transfers between periods. For those activities which take place wholly in periods 3 or 4 these are distinguished according to the market condition *s* under which they are followed.

B_{jm} are supply constraints on commodity/ resource *j* in period *m*

Commodity/ resource *j* include land, labour, cash stocks, maize stocks, purchased crop inputs, and post harvest cash crop stocks.

j m* is the subset of commodities/ resources directly consumed by the household and for which consumption is included in the objective function: cash consumption by period, consumption of maize (or calorific equivalents from other crops) by period, leisure ('slack' labour) by period, and end of season cash savings.

Equation 1 maximises expected utility using a linear expenditure system (LES). Equations 2 and 3 describe constrained resource use and production opportunities in different periods, with buying and selling of those commodities and resources for which there is a market, stock transfers between periods where appropriate, and household consumption where appropriate. Equation 3 allows for alternative stocking, market and off farm employment strategies to be followed under different market conditions (maize price regimes) in the harvest and post harvest periods, and to this extent allows for some embedded risk[7]. Equation 4 ensures that the model maintains the same opening and closing stocks from year to year and does not generate artificial windfall gains by portfolio changes (for example by replacing maize stock by cash).

The model also included upper bounds on some activities (for example input purchases financed by sale of labour). These were introduced to represent practical constraints not allowed for in the general formulation, describing, for example, the effects of timing of activities within time periods (inputs cannot be purchased at the beginning of the cropping period using wage earnings from the end of the cropping period) and constraints on specific activities (a major issue here and discussed in more detail later are constraints imposed on hiring out labour to represent limited demand in a market that does not clear).

This model structure allows the following features of farm-household livelihoods to be represented:

1. *Seasonal* constraints: The year is divided into four periods. In the 'cropping period' crops make heavy demands on labour and there are potential trade-offs between on-farm work (generating returns later, at harvest time) and off farm work (generating more immediate returns which, for cash and food scarce, poor households, may be needed to sustain minimal levels of cash and food consumption prior to harvest since households are not able to borrow to meet their immediate consumption needs). In the pre-harvest period there is limited on-farm labour demand and hence limited demand for off-farm work. In the harvest

[7] To reduce the complexity and size of the model the base formulation only explicitly allows for risk and uncertainty in maize prices, and even here uses a simple maximisation of expected utility. The model does not allow for uncertainty in yields, or for embedded risk during the cropping and pre-harvest periods as regards the effects of, for example, sickness on labour and cash availability, although these are likely to be important considerations, particularly for poorer households (Dorward and Parton 1997, Dorward 1999).

period crop prices are expected to fall and farm labour demand and off farm wage rates rise. In the post harvest period crop prices rise are expected to rise, some farm labour is required for land preparation, and there are more off farm employment opportunities (for example in petty trading, in building, collecting grass, etc).

2. *Varied activities*: a range of different cropping activities can be modelled within this structure, with varying seasonal demands for labour and purchased inputs, and different types of seasonal activities. The model structure allows flexibility in linking these to stocking and buying and selling activities across and within time periods. Off farm activities can be described in terms of hiring out of labour at differing rates in different periods. Borrowing (for cash or tied crop inputs) can also be described, although this has not yet been explored in the Zimbabwe case. Technical change and the introduction of new crops or new income earning opportunities can be described by the introduction of new activities into the model.

3. *Partial engagement with imperfect markets*: imperfect markets were allowed for by introducing a 'wedge' between market, farmgate and local purchase prices. Farmgate sales prices are therefore calculated in the model as market prices less a mark-down, and consumer purchase prices as market prices plus a mark-up[8]. Imperfect markets are represented primarily by a large mark-down depressing farmgate prices, as well as by price uncertainty in food markets (discussed below). The market wedge varied between households in different areas with different access to markets. Transaction costs (but not risks) are also allowed for in unskilled labour markets, with time demands for supervision when hiring in labour, and when hiring out labour there are time demands for travelling costs (although these are relatively small as the majority of labour transactions are assumed to take place within the locality. Over-supply on the casual labour market (and a wage above the market clearing wage due to social norms and non-market relations affecting employer/employee relations) is allowed for partly by introducing search costs (in terms of time) for those seeking employment[9]. Constraints on access to employment were also introduced to allow for social relations which allow a non-clearing wage. Complete credit market failure is assumed in the base runs described here.

4. *Food security objectives in uncertain markets*: It is frequently argued that uncertainty as regards the reliability and costs of purchasing food cause smallholders to set a high premium on subsistence maize production, inhibiting specialisation in otherwise more productive activities. Food consumption was modelled in terms of calorific requirements which could be met in different ways according to season. In the crop and pre-harvest periods maize could be consumed either from stocks carried forward from the previous season (different household types carried forward varying stocks to support this) or from purchases. In the harvest and post-harvest periods calories could be provided from own farm maize production, from own farm production of other crops (small grains), and from

[8] To reflect variation between seasons as regards local maize demand and supply, farm gate (sales) prices in the 'crop' period were not subject to the mark-down explained earlier (to allow for local demand), whereas in the harvest and post harvest periods maize could be purchased at the farmgate (marked down) price, to reflect local supply (all purchases, however, incurred a mark-up to represent buying costs).

[9] The model also allows for income from non-farm skilled and semi-skilled labour. If a household has such labour it may be sold off the farm for a higher wage (subject to constraints on access to employment) or used on farm (in which case it is treated as identical to other household labour). No attempt is made to model specific non-farm enterprises (for example in terms of capital requirements) and all non-farm activities (skilled or unskilled) earns a wage, recognising that this might in fact represent self employment in, for example, cutting firewood or thatching grass, or petty trading.

purchases of maize. Subsistence production of maize was therefore encouraged by the wedge between maize purchase and sales prices, as discussed above. The effect of food price uncertainty on farmers' food security considerations was modelled by introducing three alternative market conditions in the base model - representing anticipated, high and low maize purchase prices – with expected prices calculated as a weighted average of these three.

5. *Non-separability*: The modelling of seasonal constraints, of imperfections in maize, labour and credit markets (as outlined above), and of household objectives means that there is potential for strong competition and interaction between consumption and production activities, particularly for poorer households affected by seasonal stock constraints and lack of access to credit.

There were two principle modifications to the Malawi model structure. The first involved the introduction of irrigated vegetable production as a cropping activity which could be undertaken outside the cropping period. Handling of hiring out of labour was also changed, with three potential wage rates (skilled, semi-skilled and unskilled). In the modelling runs reported here, if constraints on access to skilled and unskilled labour markets prevent some skilled or semi-skilled labour earning their respective wage rates off-farm, then the labour in question had to be employed on farm as if it was unskilled labour. However, there is potential for these hiring rules to be modified. There were minor changes to the ways that different crops related to grain stocks and household food consumption, and with differences in characteristics between different households.

The model has also been designed to simulate behaviour under three distinctive states of nature: good, average and poor seasons (weather-wise). Both yields and crop prices vary according to the state of nature. In the simulations reported year, only behaviour and outcomes under the "good" state of nature are considered (1996 was a good year). However, further work could permit a somewhat more sophisticated treatment of risk, with, for example, households planning their activities in the cropping period based on expectations of an average season, but actual outcomes then being simulated for each of the three states of nature[10].

Heterogeneity between households as regard resource access and consumption requirements and between agricultural opportunities in different areas in Zimbabwe was achieved by varying resources, price and technical coefficients within the standard model structure according to a typology developed for the purpose. The broad structure of these household types is shown in table 3.1 (see Poulton 2002 for further details).

[10] Note that even this would not adequately allow for the incorporation of "insurance" crops, such as small grains, into household cropping strategies.

Table 3.1 Household Typology

Type	Natural Regions	Member-ship	Female-Headed	Education	Land	Cattle	Remitt-ances	Market Access	Crops	Total households
1	NR1-3	Small	No	High	Small	High	No	Far	H	30,000
2	NR1-3	Small	No	High	Small	High	No	Near	-	25,000
3	NR1-3	Small	Yes	High	Small	Low	Low	Near	H	25,000
4	NR1-3	Large	No	High	Large	High	High	Near	-	30,000
5	NR1-3	Large	No	High	Large	High	High	Far	H	20,000
6	NR1-3	Large	No	High	Large	High	No	Far	C	20,000
7	NR1-3	Large	No	Medium	Small	Low	No	Near	H	21,000
8	NR1-3	Old	No	Low	Small	Low	Low	Far	-	20,000
9	NR1-3	Old	No	Low	Small	Low	No	Near	H	20,000
10	NR1-3	HIV	No	Medium	Small	High	No	Far	-	30,000
11	NR1-3	HIV	No	Medium	Small	Low	Low	Near	H	20,000
12	NR1-3	Small	Yes	Medium	Small	Low	Low	Far	MH	20,000
13	NR1-3	Small	Yes	Medium	Small	High	No	Far	C	20,000
14	NR1-3	Small	No	Medium	Small	Low	Low	Near	MH	25,000
15	NR1-3	Large	No	Medium	Large	High	Low	Far	H	34,000
16	NR1-3	Large	No	Low	Small	Low	No	Near	-	22,000
17	NR1-3	Small	Yes	Low	Small	Low	No	Near	H	30,000
18	NR1-3	Small	No	Low	Small	Low	No	Far	C	30,000
19	NR1-3	Large	No	Low	Small	Low	No	Far	H	23,000
20	NR4-5	Small	Yes	High	Small	Low	No	Far	-	30,000
21	NR4-5	Small	Yes	High	Small	High	No	Far	H	20,000
22	NR4-5	Small	No	High	Small	Low	Low	Near	-	25,000
23	NR4-5	Small	No	High	Small	Low	No	Near	H	20,000
24	NR4-5	Large	No	High	Large	High	High	Near	C	25,000
25	NR4-5	Large	No	High	Large	High	No	Near	H	30,000
26	NR4-5	Large	No	High	Large	High	High	Far	-	35,000
27	NR4-5	Large	No	High	Large	High	No	Far	H	35,000
28	NR4-5	Old	No	Low	Small	Low	Low	Far	-	25,000
29	NR4-5	Old	No	Low	Small	Low	No	Near	H	30,000
30	NR4-5	HIV	No	Medium	Small	High	No	Far	C	20,000
31	NR4-5	HIV	No	Medium	Small	Low	Low	Near	H	20,000
32	NR4-5	HIV	No	Medium	Small	Low	Low	Far	-	30,000
33	NR4-5	Small	Yes	Medium	Small	High	No	Far	H	20,000
34	NR4-5	Small	Yes	Medium	Small	Low	No	Far	-	25,000
35	NR4-5	Small	No	Medium	Small	Low	No	Near	H	20,000
36	NR4-5	Large	No	Medium	Large	High	High	Far	C	25,000
37	NR4-5	Large	No	Medium	Large	High	No	Far	H	30,000
38	NR4-5	Large	No	Medium	Large	High	No	Near	-	20,000
39	NR4-5	Small	Yes	Low	Small	Low	No	Far	H	30,000
40	NR4-5	Small	Yes	Low	Small	Low	No	Near	-	25,000
41	NR4-5	Large	No	Low	Large	High	Low	Far	H	20,000
42	NR4-5	Large	No	Low	Large	Low	No	Far	C	35,000
Total										1,060,000

Crops Key: H = (winter) horticulture; MH = market (year-round) horticulture; C = cotton

Two major agro-ecological zones were identified (Natural Regions 1 to 3 were grouped together into one zone, and Natural Regions 4 and 5 into another) and then a classification developed within each zone based on relations between access to land, household composition (affecting labour resources and consumption requirements, male- and female-headedness), education of workers (affecting the ability to gain skilled, semi-skilled and unskilled employment), cattle holdings, receipt of remittances, distance from major centres (affecting local prices) and ability to produce particular high return crops[11]. A total of 42 household types were identified, 19 in Natural Regions 1 to 3 and 23 in Natural Regions 4 and 5. The model was written in GAMS code (Brooke *et al.* 1998) with a main file that established the structure of the model, calling up data on different household types, a solve routine, and a reporting routine[12]. Model outputs were captured by Excel spreadsheets to provide the analysis presented in this paper.

3.2 Farm/household model data sources

Modelling the range of constraints and opportunities of the various household types as described above makes very challenging demands for data. A helpful way of categorising data requirements is to distinguish between technical coefficients (the input:output relationships for the range of activities and situations to be modelled), price coefficients for inputs and outputs in different situations and time periods, and scale coefficients (for example quantities of resources available or of products required).

One of the advantages of using a programming model is its use of discrete activities, with fixed technical (input/output) coefficients for each 'activity' modelled, where, for example different ways of growing the same crop (different 'technologies') are modelled as different activities. This approach requires relatively simple physical or financial budgets relating resources used (principally land, labour and inputs, by time period) to outputs for all activities included in the model (crops and non-farm activities, taking account of different possible technologies and of differences between different household types and different areas). For all marketed inputs and outputs, including labour, prices are also needed, ideally taking account of variation over the course of a year (between the cropping, pre harvest, harvest and post-harvest periods), of variation between different household types, and of differences between purchase and selling prices (consumer and farmgate prices). Given the variability and heterogeneity within smallholder agriculture, and the operation of partial and imperfect markets in peasant economies, obtaining such information presents major conceptual challenges even where substantial resources are available for primary data collection. The aims of this project (to develop stylised or 'typical' understanding of processes, opportunities and constraints in pro-poor growth with analytical methods providing some integration of micro-, meso- and macro- components) precluded a large, costly and lengthy data collection exercise. Use was therefore made of existing data sources. This involved 'patching together' information gleaned from a wide variety of sources, and these are listed in Appendix 1. Particular difficulties are faced with labour data, as regards hours worked by

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[11] Specifically, only a limited number of households were permitted to engage in horticultural and cotton production. The restrictions here capture the facts that: 1) water availability restricts the number of households that can engage in any significant horticultural production and, even more so, in year-round production. (Within communal areas, it is essentially only a limited number of households in Mashonaland – that also have reasonable access to Harare markets - that can produce horticultural crops year-round); 2) cotton production opportunities are a function of the geographic coverage of the main cotton companies (3 in 1996). In major cotton producing areas, over 90% of households have some involvement in cotton, so expansion has to come primarily from opening up new areas and the initiative for this generally has to come from the companies, rather than the farmers. Note that such an expansion did occur in the latter part of the 1990s, when it is estimated that the number of communal cotton producers more than doubled.

[12] Code is available on request from A.Dorward@imperial.ac.uk.

different household members, hours required by on farm tasks, and wage rates. While labour supply and use are difficult to study, and wage rates are very variable, it is nevertheless remarkable that there is so little systematic information on these topics when labour markets and returns to labour are so important to the poor, to 'coping strategies' and to processes of poverty reduction. For these topics, and for others where data sources were limited or gave conflicting information, pragmatic judgements were made, and, for wage rates for example, the effects of alternative assumptions were investigated as regards the balance between hiring in and out of labour in different household types. Data sources are listed in Appendix 1[13].

3.3 Farm/household model: base results

The model can be used to generate estimates for a wide range of parameters: crop areas, crop production, farm input use, household incomes and income sources, expenditure patterns, and labour market participation. Many of these estimates can be obtained by household type, aggregated for two agro-ecological zones, and aggregated for Zimbabwe's communal areas as a whole. In this section we present and discuss model estimates of these parameters using the 'base scenario' for the 1995/96 cropping season. We present and examine these results with two objectives: to evaluate the validity of the model, and to explore insights from the model regarding the structure of the rural economy.

A striking finding during model development was the high returns to off farm labour as compared to most cropping activities (with the exceptions of horticulture, cotton and high yielding maize activities). As a result of these relative returns, initial model runs led to very low participation in agriculture, which was reduced basically to just the three crops noted above. These results are unrealistic, as regards their representation of very low household engagement in agriculture and of high levels of household welfare (derived largely from hiring out labour)[14], with reliance on unrealistically large demands for rural labour from activities supplying tradable goods and/or services to other sectors of the economy. These results demonstrated that the model was failing to properly represent reality in one or more of three areas: agricultural labour productivity, wage rates, or non-market constraints on access to employment. Internal consistency of the model and comparison with overall crop and labour balances suggested that agricultural labour productivity and wage rate coefficients were probably roughly correct, leading to the conclusion that non-market constraints on access to employment are important and were not represented in the model [15].

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[13] For further information on data and assumptions used in the models, contact C.Poulton@imperial.ac.uk

[14] Estimated poverty incidence of 43% and extreme poverty incidence of 16% (assuming a coefficient of variation in within-group income of 0.5) are lower than expected from other sources of information – see table 3.3 and associated discussion.

[15] This assumes that rural labour markets do not clear on the basis of wage rate adjustment. For example, social ties may ration access to employment by determining who can and cannot get work at a socially determined "fair" rate, which is actually above the rate at which the market would clear. There is some support for this conceptualisation of rural labour markets in the literature reviewed by {Leavy, #618}. For example, they report a 1991 paper by Adams on rural labour markets in Masvingo, Zimbabwe, where "Employers preferred insiders as they are a 'known quantity' (i.e. overcoming information asymmetry) with respect to dependability and work capacity" (p9). They also report studies in Kenya and Rwanda reported in a 1997 paper by Reardon "which show that the marginal value product of farm labour for the smallest quartile of farms is well below farm labour market wage which in turn is well below the non-farm wage. These results indicate … a 'bottling up' of labour on farms due to market failure" (p11). By contrast, in the Malawi modelling work that accompanies this Zimbabwe work, returns to own farm labour were found to be generally higher than wages obtainable from casual ("ganyu") labour.

These difficulties emphasised to us how little we know about rural labour markets in Zimbabwe (indeed, in Africa as a whole) and the need for greater research on this. We know of no data on rural labour demand, or indeed of actual labour hire activity in 1996, and for the base scenario therefore resorted to two somewhat arbitrary constraints on households' ability to hire out their labour: hiring out of labour at skilled and/or semi-skilled wage rates was limited to half the available skilled and semi-skilled labour in the household; and hiring out of unskilled labour was limited to half the available unskilled labour in the household[16].

Initial runs of the model led to infeasible solutions for households 29, 30, 34, 39, 40 and 42. These are all households in Natural Regions 4 and 5 without remittances and with particular challenges such as being affected by HIV, being elderly with a high dependency ratio, and for the most part without any skilled or semi-skilled labor. The infeasibility concerned insufficient initial grain or cash stocks and insufficient labour hiring opportunities or capacity to provide for their minimum consumption needs up to harvest time. To overcome this the initial cash stocks of these households were supplemented by transfers of Z$200, Z$300), Z$200, Z$400, Z$600 and Z$300 respectively [17] [18]. Such transfers might be thought of as gifts or handouts from relatives or neighbours within the village, which is often how the poorest households in African rural society survive.

Table 3.2 presents the base scenario cropping pattern and production estimates from the model and compares them with CSO estimates for 1996 Central Statistical Office 2001.

Table 3.2: Base Scenario Crop Production Estimates

		Maize	G/Nuts	Cotton	Small Grains	Bambara Nuts	Sun-flower	Hortic.
Hholds Growing Crop ('000)	Model estimate	988	637	176	249	91	93	544
	CSO Estimate	958	400	112	400+	195	90	
	% Difference	+3.1%	+59.1%	+56.6%	-38.8%	-53.2%	+3.4%	
Area Planted ('000ha)	Model estimate	1,125	329	199	124	12	73	
	CSO Estimate	1,172	105	167	462	299	45	
	% Difference	-4.0%	+214%	+18.8%	-73.2%	-59.8%	+62.0%	
Average Yield (kg/ha)	Model estimate	1,427	432	949	250	300	475	
	CSO Estimate	949	471	819	250	365	416	
	% Difference	+50%	-8%	+16%	0%	-18%	+14%	
Production ('000 tonnes)	Model estimate	1,605	142	188	31	4	35	950
	CSO Estimate	1,113	49	137	115	11	19	
	% Difference	+44.3%	+188%	+37.7%	-73.2%	-66.9%	+85.1%	

[16] We examine later how opportunities to hire out labour (constrained or unconstrained) affect households' responses to other changes in conditions and/or policy.

[17] In 1996 the exchange rate was roughly US$1=Z$10

[18] A variety of other changes could also be used to address the infeasibility problem. From a livelihoods perspective, these households could cope if a) they could hire out a higher proportion of their (unskilled) labour than the 50% allowed (i.e. if labour markets were tighter); b) grain prices within NR4-5 areas rose by less during the course of the year, or c) they periodically reduced their consumption below a reasonable minimum (the likely coping strategy in practice).

Table 3.2 shows close agreement between model results and the CSO estimates as regards the number of households cultivating maize and sunflower, and cultivated area of maize (and to a lesser extent cotton). At the same time, there is considerable divergence between model and CSO estimates for maize yields (and therefore production), for groundnuts areas and production, and for areas and production of minor crops[19]. However, with the exception of small grains, the relative importance of the different crops is correct and, for the minor crops, large percentage divergences represent quite small absolute differences. Small grains are under-represented in the model cropping activities, as the model does not describe households' strategies for dealing with climatic risk, and small grains are planted at least in part as a strategy for coping with bad years.

Thirteen household types (representing 34% of communal households) are net maize sellers through the course of the year, whilst 29 (66% of communal households) are net maize buyers. The top three household types (8% of the communal population) sell 65% of all maize sold by communal households and the top third (thirteen household types) account for 98% of all maize sales. This is consistent with work by Jayne and Chisvo 1991, Weiner 1988 and others, which found that anything up to 70% of communal households were net maize deficit in a typical year and that the bulk of smallholder maize surpluses were sold by a relatively small proportion of better endowed households in higher potential areas.

There are two particular respects in which the model does not capture communal farmers' behaviour:

Participation in cash crop production (notably cotton and market horticulture) is associated in the model with reduced production of maize, compared to similar households without the same cash cropping options. By contrast, Jayne 1994 and others have found that participation in cash cropping in Zimbabwe occurs primarily amongst households that are able to first feed themselves from own production. This suggests that the model does not sufficiently capture either the transaction costs or the risks associated with specialising in cash crop production and hence relying on the market for basic food supplies.

Second, model results show that 28% of land in NR1-3 is left fallow, but only 3% in NR4-5. We would, however, expect the proportion fallowed to be higher in NR4-5 than in NR1-3. The model outcome is the result of a combination of a) the low returns to agriculture compared to non-farm labour (encouraging labour supply off-farm), and b) the higher yields possible in maize production in NR1-3 compared with NR4-5, meaning that own maize consumption requirements can be satisfied from a smaller area of land in NR1-3 than in NR4-5. If opportunities for off-farm labour were to be further restricted, beyond the current restrictions described earlier, the amount of fallow land would be reduced – and the proportion of income obtained from agricultural production would rise.

Table 3.3 presents information regarding income and poverty incidence estimates. Income, and particularly agricultural income, is almost certainly under-estimated by the model, as it ignores production of minor crops such as pumpkins scattered and mixed in with the field crops, and livestock production is also ignored[20]. On the other hand crop production is generally higher than CSO estimates (as shown in table 3.2). Off farm income may be over- or under-estimated, as we discuss below. The extent of omitted income will vary between households, and will probably be greatest for better-off households with livestock. On the basis of experience with similar modelling in Malawi, where modelled income estimates could be directly compared with information from

[19] Note that the CSO estimates themselves are of questionable reliability.

[20] Although ownership of livestock is included in the household typology, the only benefit to livestock ownership that the model captures is the ability to plough land immediately after rains, hence contributing to achievement of better yields.

household expenditure survey, household income estimates from the model were increased by 25% when calculating poverty incidence. Using this adjusted income for each household type, poverty incidence was then estimated by assuming a log normal distribution for the distribution of household income within each household category, with a coefficient of variation of either 50% or 75%. This allowed calculation of the estimated proportion of households lying below the poverty and ultra-poverty lines.

Table 3.3 Model estimates of household income and poverty incidence

		NR 1 - 3	NR 4 & 5	Total
Mean household income (Z$ per capita) [21]				1,435
Poverty incidence[22]	CV=0.5	46%	55%	51%
	CV=0.75	54%	60%	57%
Ultra-poverty incidence	CV=0.5	22%	26%	24%
	CV=0.75	32%	37%	35%
Income from smallholder agriculture		38%	27%	

As noted by Poulton, Davies *et al.* 2002, there was considerable debate about appropriate rural poverty lines in Zimbabwe in the early-mid-1990s. The figures in Table 3.3 use the 1990 rural poverty line calculated by World Bank 1995, inflated by the CPI to give comparable 1996 levels. In our view, this is an appropriate rural poverty line. However, we lack estimates of poverty in Zimbabwe communal areas in 1996 based on this poverty line against which we can compare our own estimates.

On the other hand, if we use the poverty line used by Central Statistical Office 1998 for their "Poverty in Zimbabwe" report (based on the 1995/96 ICES survey), then the model estimates 81% of communal households being classed as poor and 50-56% being classed as very poor (depending on the coefficient of variation used in our calculations). This compares with the CSO's own figures of 82% of communal households being classed as poor and 57% being classed as very poor (p52). Thus, we have a remarkably good fit with CSO estimates.

3.4 Sensitivity Analysis

3.4.1 Varying Maize Prices

Starting from the base case described above, sensitivity analysis was performed, allowing maize prices to vary from 0.5 to 1.5 times those of the base case [23]. We consider NR 1-3 and NR 4-5 in turn.

[21] Unlike for the poverty calculations (see footnote 22), no adjustments are made to the income estimates derived from the models to arrive at this figure.

[22] Note that, in all poverty calculations, 25% is added to estimated incomes before the poverty figures are calculated.

[23] One other change from the base case was introduced: households otherwise unable to support minimum calorie consumption requirements were allowed to reduce these to 0.95 or 0.9 times the "basic" level. This removed the need to increase initial cash stocks for households 29, 30, 34, 39, 40 and 42 (as described earlier for the base run).

3.4.1.1 Varying Maize Prices in NR1-3

The following notable changes are observed within NR1-3 as the maize price was increased over this range:

- A number of household types (numbers 3,16,17,18,19) cultivate no maize when prices are 0.5 times the base case, but cultivate 0.15ha or more by the time the price has reached 1.5 times the base case. Several other household types (numbers 2,4,5,6,8,11,13,15) witness a doubling or more in the area that they plant to maize.
- In line with these increases in cultivated areas are increases in maize production and sales. Two wealthy household types with large land areas at their disposal (numbers 4 and 5) dramatically increase their maize production and sales. However, this increase occurs mainly as prices rise just above 0.5 times the base, and is largely complete by the time the maize price reaches the base level. A number of other household types (hh1,2,3,8,11,15) increase their maize sales from nothing to two tons or more as the price rises. These are all household types with external resources coming into the household (through wage earnings or remittances), although household types 8 (old) and 11 (HIV) are in other ways quite poor.
- There is a dramatic aggregate increase in the volume of maize sales as the price rises from 0.5 to 0.8 times the base price, a steady aggregate increase in the volume of maize sales in response to price increases in the range 0.8-1.3 times the base price, and a tailing off in the response after it passes 1.3 times the base price. These simulations suggest that the GMB could have stimulated an increase of 9% in the marketed maize surplus by setting a purchase price 10% higher than was actually set in 1996. On the other hand, the fact that many producers receive less than the GMB purchase price (as low as 50% of this price in some cases, although in our models the greatest discount is 27%) would appear to have a major negative impact on the volume of maize that they produce and sell.
- Rising areas planted to maize do not necessarily translate into rising total areas cultivated. Household types 2,6,7,9,10,16 and 17 all see the total areas that they cultivate fall (albeit unevenly) over the range of maize prices analysed here, with sunflower and (to a lesser extent) cotton areas gradually reducing as maize prices rise. Sunflower areas contract faster than maize areas grow because maize is both more labour and capital demanding per unit area than sunflower.
- Rising maize prices are good for net income per capita in some households (those who can produce surpluses of maize) as they generate higher incomes, but rising maize prices are bad for other households (those who are net buyers of maize). Five household types (1,2,4,5,15) see net income per capita rise by 10% or more as maize prices rise from 0.5 to 1.5 times the base case, whilst seven types (7,9,13,16,17,18,19) see net income per capita fall by 10% or more. Importantly, these seven are seven of the eight poorest types in NR1-3.
- Predictably, calorie consumption falls across all household types (with one exception) as maize prices rise. In addition, three household types (9,16,19) fail to maintain their basic minimum consumption requirements as maize prices rise above the base level.
- At the base maize price, four household types (the two market horticultural producers and the two biggest maize surplus producers) hire in unskilled labour. As maize prices rise above this level, another six household types begin to hire in labour. The total quantity of labour

demanded rises 25% as maize prices rise from the base level to 1.5 times this level. At the same time, a number of households (1,8,15) reduce their off-farm labour supply[24].

The impact of rising maize prices was also investigated without constraints on the maximum proportion of labour that could be hired out. Under these conditions there is a similar pattern in terms of the household types that gain and lose as maize prices rise, except that there is a generally lower effect on incomes in percentage terms (as incomes are generally higher but on-farm production lower). At the same time increasing areas planted to maize as maize prices rise are more likely to translate into increases in total area cultivated.

3.4.1.2 Varying Maize Prices in NR4-5

Meanwhile, within NR4-5 we observe the following as the maize prices are increased:

- As there is less fallow in our base case in NR4-5 than in NR1-3, there are fewer changes in total land area cultivated as the maize price rises. Moreover, most of the observed changes are worked through at prices below the base maize price. Only one household type (29) sees its total cultivated area fall over the range of maize prices analysed here.
- Within these totals, however, mean maize area planted more than doubles (from 0.71 to 1.51 ha per household), reflecting the lower yields in NR4-5 compared with NR1-3, hence the need to make greater area adjustments to achieve a given increase in maize production.
- By the time the maize price reaches 1.5 times the base case, fourteen household types are making maize sales (four of these selling between one and 1.5 tons per household), but still only six are net maize surplus over the whole year.
- Irrespective of the maize price, only two household types (two of the four cotton producers) hire in any agricultural labour. This is despite the fact that higher maize prices would raise the returns to labour under some maize technologies above the wage rate for hired labour.
- The six household types that required increases in initial cash stocks to sustain basic minimum consumption levels in the base case all fail to sustain even 90% of these levels as maize prices rise above the base price. Two additional household types (33,35) fail to sustain basic minimum consumption levels as the maize price rises above the base level. Conversely, four types (27,37,38,41), all with large land areas, livestock and some financial resources with which to cultivate the land, see their net income per capita rise by 10% or more as maize prices rise.

From these simulations, we draw the conclusion that using higher maize prices to stimulate production through greater uptake of existing technologies will benefit almost exclusively better-off households, at least in NR4-5, whilst worsening the poverty and food security situation of (a larger number of) the poorest households. In NR1-3, the negative impacts on poorer households will be offset by "secondary" effects of greater maize production: the tightening of local labour markets through increased demand for hired labour and increased demand for non-tradable goods and services as the incomes of maize surplus producers rise. We cannot say whether the positive or negative effects will be more significant for poor household types in NR1-3, as the "secondary" effects are not captured in our models. However, we conclude that efforts to promote maize intensification should be based primarily on the generation and dissemination of new technologies that permit increased returns to labour at existing (and lower) maize prices. In NR4-5 the primary

[24] This undoubtedly represents a tightening of local labour markets. However, given our inability so far to model these markets, we cannot say what effect, if any, this will have on wage rates. At the returns to labour and wage rates prevailing in our model, the households in NR1-3 taken as a whole still look to sell considerably more unskilled labour than they look to buy in, even when maize prices are 1.5 times the base case.

aim should be to assist households to achieve a greater degree of self-sufficiency. Expanded maize production is unlikely to provide much of a broader stimulus to growth in these areas.

3.4.2 Reducing Maize Price Variability

Uncertainty over future maize prices is widely thought to be an important influence on agricultural production behaviour by smallholder households. Where cash crops offer higher expected returns to labour than food crops, but there are perceived risks involved in depending on market purchases for basic food supplies, households may concentrate on production of food crops at the expense of higher return cash cropping activities, thereby lowering incomes (Fafchamps 1992).

As already noted, our models may only partially capture the perceived risks involved in depending on market purchases for basic food supplies. In addition, as already noted, there are only two cash crops within the model that provide significantly higher returns to labour than maize production or (equally importantly) than off-farm labour (these are market horticulture and cotton). Thus, when the probability-weighted expected maize price in the 1996-97 season is reduced to the 1996 post-harvest price (i.e. a credible pan-seasonal pricing policy is introduced), the changes in cropping pattern are quite minor. The mean area planted to maize falls by just 0.1ha (from 1.06ha per household to 0.96ha), with some upward adjustments in the areas planted to groundnuts and left fallow. There is no boost to other cash crops because only a limited number of households are permitted by the model to engage in market horticulture and cotton and these are generally already engaging in them to a high degree in the base case. The poverty statistics are thus unchanged by the simulated change.

We nevertheless suggest that the models currently understate the importance of achieving greater maize price stability. In addition to the imperfect capturing of transaction costs and/or risks already alluded to, the models are closed by requiring households to end the year with the same cash and maize stocks with which they began. Thus, maize deficit household types that were assumed to start the year with no maize stocks do not have to buy in any maize to replenish stocks at the end, so are only affected by the difference in expected price during the 7 months of the harvest and post-harvest periods when maize prices are lowest. At the other end, maize surplus household types (34% of communal households, according to our estimates reported earlier) are also largely unaffected by the change. This suggests the need for some refinement of the basic model in future.

3.4.3 Varying Unskilled Wages

Again starting from the base scenario described earlier, a second set of sensitivity analyses was performed, this time allowing unskilled wages to vary from 0.75 to 1.25 times those of the base scenario.

The following notable changes are observed within NR1-3 as the unskilled wage rate varies:

- As the wage rate rises, the mean area cultivated falls. This is caused by a few households (most notably the two main maize surplus producers mentioned earlier) cutting back on the labour they hire in, whilst some additional households increase the amount of labour they hire out. However, for the majority of households the effects are not pronounced. We also note that most of the changes have occurred before the wage rate reaches our base level. By this stage, the returns to off-farm labour are higher than the returns to labour in most cropping activities, so additional increases in the wage rate make relatively little difference to cropping decisions.
- Maize production by major surplus producers generally declines (by over 50% in the case of household types 3 and 5, as wages rise from 0.9 to 1.25 their base level).
- However, on a much smaller scale, production by some poorer household types (7,9,10,17,19) rises with wages. This “perverse” supply response indicates the severity of the resource (cash

and/or maize) constraint that faces these household types in the production and pre-harvest periods. Rising wages permit the households either to work less and still be able to purchase enough maize to meet minimum calorie requirements or to purchase additional production inputs on top of meeting minimum calorie requirements through maize purchases[25].

- Maize purchases by the poorest households also rise with wages. Maize and calorie consumption by all household types rises, or is at worst static, as wages rise.
- The mean (total) poverty count amongst the poorest seven household types falls from 89% to 78% as wages rise from 0.75 to 1.25 times those of the base case. The fall in the mean (food) poverty count amongst the same household types falls even faster, from 60% to 43%.

In NR4-5 the basic story shows many similarities to the NR1-3 story (poorer households generally benefiting, less poor households sometimes becoming worse off) although the precise dynamics are different:

- Three household types with large land holdings, livestock and (semi-)skilled wage income shift out of groundnuts production towards maize as wage rates increase. This is because the higher wages permit extra expenditure on purchased inputs. (Fertilised maize production generates higher returns to labour than groundnuts, but with higher initial capital requirements).
- Meanwhile, a few poorer households (especially households 39 and 42) shift out of maize and cultivate a progressively smaller area as wages rise. Household type 39 shifts into production of small grains, but also takes more leisure as wages rise, reflecting the fact that, despite its poverty, no agricultural opportunities are particularly attractive to its members. Household type 42 is able to commence a limited amount of cotton production (using own labour), as wages rise sufficiently to ease its seasonal capital constraints.
- Conversely, the main cotton producing household type reduces its maize production as wages rise, as a result of reduced ability to hire in labour for its cotton production activities.
- One medium poor household type (22) sees its poverty rate rise. Household types 30, 39 and 42 witness an initial increase in poverty (until wages reach the base case level) before seeing their poverty rates fall subsequently. Increasing wage rates can lead to increasing poverty incidence where households earn a relatively small proportion of their income from the labour market, as real incomes used in poverty incidence calculations are adjusted for (1) changes in maize prices weighted by the proportion of expenditure on maize, and (2) changes in wages weighted by the proportion of expenditure on non-tradables (as non-tradable prices are likely to be very dependent on local wage rates). At low wage rates household types 30, 39 and 42 hire out very little labour and hence their real incomes are negatively affected by increases in wage rates, but as wages rise further they switch more labour into off farm employment and thereafter their real incomes gain from wage increases.

When the same sensitivity exercise is performed in NR4-5 with unconstrained hiring out of labour, some different dynamics emerge:

[25] In Malawi model simulations, poor households are also observed to *increase* maize production as maize prices fall (a backward sloping supply curve). This is because the benefits of the reduced expenditure on maize in the production and pre-harvest periods, freeing resources for additional production, outweigh the "disincentive" of lower maize prices at harvest time. In the Zimbabwe case, the five household types discussed here (7,9,10,17,19) all *reduce* maize production as maize prices fall. Whilst they do benefit from reduced expenditure on maize in the production and pre-harvest periods, they devote the resources saved to increased sunflower (not maize) production.

- Household types 25,26,27 and 41 see a sharp one-off fall in area cultivated just before or at the base wage level. These are large households with large land holdings that suddenly find it attractive to shift extra labour off-farm as wages rise.
- By contrast, household types 29,30,39,40 and 42 (several of the poorest types) increase the area of land that they cultivate throughout some or all of the range of increasing wages (although they nevertheless cultivate considerably less than they do in the base case when labour opportunities are constrained). In all cases, the increase in cultivated area is accompanied by a small reduction in hiring out of labour as wages rise. The increase in cultivated area is largely accounted for by expanded maize production, plus, for types 30 and 42, additional cotton production. Both types 30 and 42 produce more cotton with unconstrained labour hire than they do when labour hire is constrained, indicating that unconstrained labour hire eventually (as wages rise) eases the seasonal capital constraint on higher value agricultural activities.
- Poverty levels fall in a linear way for most household types, with the exception of types 21,22,24,26 and 36, which see tiny rises. Types 24 and 36 (cotton producers) both hire labour in, so find this more expensive as wages rise. Household 26 only hires out a small quantity of unskilled labour, preferring to take leisure time instead. However, the real income figures that provide the basis for the poverty calculations are adjusted slightly as wages rises, as the cost of locally produced non-tradable goods and services (which all households buy) are assumed to be affected by wage rates.

Overall, these simulations show the importance of unskilled wage rates to poverty reduction. However, achieving a sustainable increase in unskilled wage rates of the magnitude simulated here would take years of expanding economic activity.

3.4.4 Varying All Commodity Prices

Finally, we explore the consequences of allowing all (crop) commodity prices to rise from 0.5 to 1.5 times the prices in the base scenario. Given our previous observations about the relationship between the off-farm labour rate and returns to labour within crop production, an increase in commodity prices, holding unskilled wages constant, might be expected to lead to some large shifts in household activities. However, we note that, even in accessible areas within NR1-3, groundnut production only offers returns to labour in excess of unskilled wage rates when the price reaches 1.3 times the base case, whilst for sunflower the threshold is only crossed when the price reaches 1.4 times the base case. The consequences of raising commodity prices within the range considered here are, therefore, not that dramatic.

Table 3.4 summarises the main aggregate results for NR1-3 as regards crop areas, welfare and labour hire, comparing impacts of increases in maize prices with impacts of increases in prices of all crops:

- The mean area under production does rise further than when maize prices alone are raised (see Table 3.4). Many household types increase their area under production by 10% or more as prices increase from their base level to 1.5 times this level. Whilst these are predominantly better off household types (1,2,3,5,8,11,12,14,15), a few poorer household types (10,17,18,19) also expand their area under production by a similar proportion.
- Unlike the case where only maize prices rise, those household types that produce less than 0.5ha of maize at base prices reduce their area planted to maize as all crop prices rise. By contrast, most household types that produce more than 0.5ha of maize at base prices increase their area planted to maize as all crop prices rise. Whilst the former types prefer to buy in maize after harvest (using the additional income from other crops as prices rise), for the latter types maize is an important part of their income and livelihood strategy.

- Three of the four household types that produce sunflower at base prices switch out of it as prices exceed 1.1 times base prices. By contrast, from 1.2 times base prices onwards, a total of seven household types (including these three[26]) increase their production of groundnuts.
- Areas planted to cotton remain virtually unchanged. The reasons for this are instructive. One household type (13) allocates all its (small) available land area to cotton irrespective of price. It shifts marginally from maize towards cotton as prices rise from 0.5 to 1.5 times the base case. One type produces 2ha of cotton (set as a maximum within the model) throughout. The third cotton growing household type (18) does not have the financial resources to expand its area planted to cotton, even as prices rise, so still has fallow land even when prices reach 1.5 times their base level. These results are obtained in the absence of any allowance for either land rental transactions or credit availability. If these were allowed in the model then we would expect a greater response of cotton production to higher prices.

Table 3.4: Comparing the Effects of Higher Maize Prices with Higher Prices for all Crops (NR1-3)

	Base Case	Maize Price * 1.5	All Crop Prices * 1.5
Mean Area Planted (ha)	1.38	1.44	1.57
Number of household types hiring in labour	4	10	11
Mean quantity of labour hired in (hrs)[27]	313	457	608
Mean quantity of labour hired out (hrs)	1905	1844	1762
Maize Consumption (kg per cap p.a.)	262	241	268
Mean real net income per capita (Z$)	1554	1627	2005
Total Poverty Count[28] (%)	49%	48%	43%
Food Poverty Rate (%)	20%	22%	16%

- Constraints on supply capability are critical to the overall impact of price rises on household net income per capita, too. As shown in Table 3.4, mean real net income per capita rises much more steeply when all commodity prices rise than when maize prices alone rise. (Moreover, all households see some increase over the price range shown in the table, whereas many households see declining real net income per capita when only maize prices rise). However, this increase is very unevenly distributed. Amongst the top six household types, mean real net income per capita rises 46% as prices rise from their base level to 1.5 times this level. The comparable figure for the poorest six household types is just 12%.

[26] At base prices, sunflower offers higher returns to April-June labour than groundnuts, even though groundnuts has higher returns to labour overall. Returns to labour in this period are apparently a critical determinant of crop choice for some households. However, as prices rise proportionately, the gross margin for groundnuts rises more quickly than that for sunflower and the relative returns in April-June are reversed.

[27] These figures are expressed as a mean across all 19 household types *weighted according to their share of the population.*

[28] The two poverty counts reported here are based on a coefficient of variation of incomes within groups of 0.5.

- Raising all commodity prices does make some dent on poverty figures, in contrast to the case where maize prices alone are raised (Table 3.4).
- The number of households hiring labour in is similar for maize price and all crop price increases (Table 3.4). However, price increases across all crops cause a greater increase in the amount of labour hired by these households. At the same time, the rate at which households hire out their labour does not drop much (reflecting the fact that the restriction on unskilled labour hire – to 50% of available labour hours per household in the base case – binds strongly for most households).

Table 3.5 presents similar information for NR4-5:

- In contrast to NR1-3, cultivated area does not expand as much when all crop prices rise as when just the maize price rises (Table 3.5). The explanation of this is that: i) the number of attractive opportunities created by the general rise in price is limited, but ii) those that are created succeed to some extent (through generating extra cash in hand) in reducing the pressure to grow maize to avoid possible high buying prices in the following season. Consistent with this, the area planted to maize by a number of household types (20,22,23,28,33,34,35,37,38,39) falls over some or all of the range of general price increases considered here.
- Two wealthy cotton producing household types (24,36) produce the maximum permissible 2ha irrespective of price levels. By contrast, two other households struggle to produce cotton when they have to buy maize at more expensive prices[29]. Type 30 reduces the area it plants to cotton as the general crop price level rises. Type 42 produces a small quantity of cotton when prices are at 0.5 times their base level, but has switched out of cotton altogether by the time prices reach their base level. This is an example of a severe cash constraint preventing a poor household from investing in what is clearly a much higher paying activity than any other that it could consider.
- There is a real diversity of patterns of groundnut production, with some households shifting into groundnuts as the returns exceed those available from off-farm labour, whilst others gradually shift out of groundnut production as prices rise. The latter phenomenon occurs where poor households suffer more from higher maize prices (constraining cash flow in the current season) than they gain from higher (end of season) prices for other crops. In a few cases (hh 29,35,39), total cultivated area is cut back as prices exceed base levels.
- Higher commodity prices have only a very slight impact on labour hire (either in or out) in NR4-5. This reflects the lack of attractive crop-based income-earning opportunities in these regions.
- The trends in net real income per capita are less differentiated than in NR1-3. The two significant gainers from higher prices are the two wealthy cotton growing household types. Amongst the remainder, household types with large land areas generally gain (albeit modestly), as do household types with small land areas but the ability to grow winter horticultural produce. Household types with small land areas and without the ability to grow winter horticultural produce are almost entirely losers from higher general crop prices.

[29] A similar dynamic is observed when maize prices alone are increased. What is perhaps interesting here is that trends in other prices at best only partially counter the trend. This is because the higher prices that we simulate include maize purchases within the growing season as well as post-harvest prices.

- Overall poverty incidence *changes in line with these income changes*, falling slightly with higher crop prices. This is in contrast to the situation where only maize prices rise (Table 3.5). However, amongst some household types, the incidence of poverty still rises.

Table 3.5: Comparing the Effects of Higher Maize Prices with Higher Prices for all Crops (NR4-5)

	Base Case	Maize Price * 1.5	All Prices * 1.5
Mean Total Area Planted (ha)	2.20	2.23	2.17
Mean Area Planted to Maize (ha)	1.25	1.51	1.18
Number of households hiring in labour	2	2[30]	2
Mean quantity of labour hired in (hrs)	83	82	104
Mean quantity of labour hired out (hrs)	2126	2120	2076
Calorie Consumption (KCal per cap p.a.)	774714	682212	728271
Mean real net income per capita (Z$)	1326	1311	1455
Total Poverty Count (%)	56.1%	56.3%	52.5%
Food Poverty Rate (%)	27.5%	28.4%	24.6%

The analysis above has primarily explored the first-round effects of raising crop prices. It does not take into account either the effects of tightening agricultural labour markets or the multiplier effects as beneficiary households spend their additional disposal income on locally produced, non-tradable goods and services. As noted above, however, these effects are not likely to be very large for NR4-5, for which the preliminary conclusion from this analysis is that, whilst poverty does fall as a result of the higher prices, the main beneficiaries of higher crop incomes are wealthier households.

Looking across results from both NR1-3 and NR4-5, therefore, we conclude that higher crop prices are more likely to contribute positively to a strategy for pro-poor agricultural growth in higher potential areas where a significant proportion of households can benefit directly from the higher prices through increased production and sales. Even though these are unlikely to be the poorest households, if they hire in labour as prices rise and/or invest more of their own labour on-farm, this will contribute to a tightening of local labour markets, which in turn will benefit the poorest households, who gain much of their income from hiring out labour (even if are unable to respond to improved crop market opportunities themselves). For lower potential areas to benefit from higher crop prices there needs to be more emphasis on off-setting transfers to protect the welfare of poorer households and on increasing the productivity of smallholder agricultural production activities. The latter fundamentally requires improved effectiveness of agricultural research-education-farmer linkages, alongside measures to increase the capacity of poorer households to respond to enhanced prices. This could include increased provision of credit or the encouragement of land rental markets. However, further analysis needs to be conducted to quantify these benefits before firm conclusions can be drawn here.

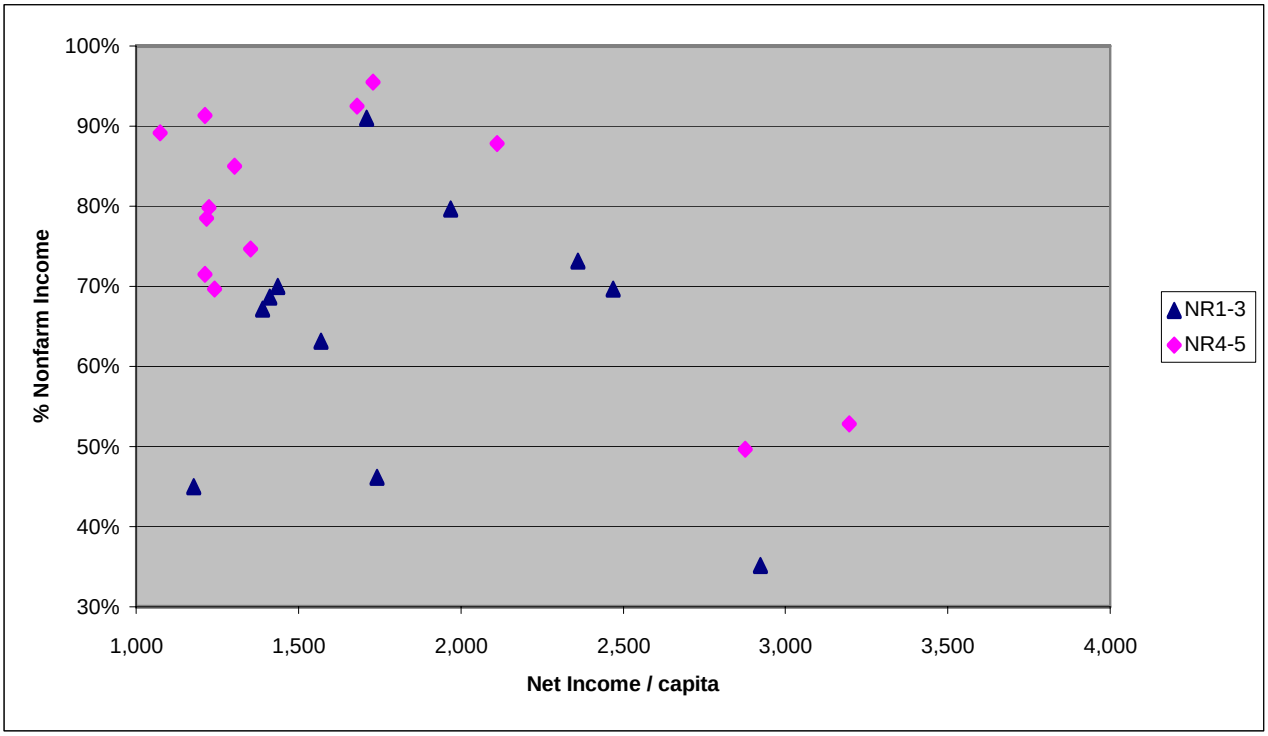
[30] Four other households hire in very small quantities of labour when maize prices are between 1.2 and 1.4 times their base level, but cease to do so when they rise to 1.5 times base level.

3.5 Household Farm and Non Farm Incomes and the Structure of the Rural Economy

This section is concerned with the relationship between farm and non-farm income in the wider smallholder economy, and possible sources of poverty reducing growth in rural areas.

Figure 3.1 plots the relationship between per capita income and farm and non-own-farm income[31] in the base case scenario for households in each zone. There is no evidence of the U shaped relationship reported by Reardon 1998 and Toulmin *et al.* 2000 and the high proportions of off-farm income are perhaps surprising (non-own-farm income accounts for above 60% of total income for most households).

Figure 3.1 %Non Own Farm income against Net Income / capita



With regard to the latter, we estimate below that non-own-farm income accounts for around 60% of total net income in NR1-3 and a little over 70% of total income in NR4-5 (with smallholder agriculture – including income from hired farm labour - accounting for 45% and 29% of total net income in NR1-3 and NR4-5 respectively), substantially higher estimates of non-farm income than the commonly cited figure of 50% for rural areas in Africa (Reardon 1998; Bryceson 1999; Ellis 1998). They are however similar to observations by by Bush 2003 and to comparable model estimates for Malawi by Dorward 2003. This reflects the large labour surpluses commented on earlier (with very little on farm labour demand but very large supplies of rural labour into the employment market), as well as the importance of remittances (which account for around 20% of net income in both zones). Overestimates of the labour surplus in the model could arise from the model underestimating labour demand from larger, better off smallholder farmers, or from overestimates of labour supply from, and income to, poorer households. The latter is unlikely, in

[31] We define non-own-farm income as non-agricultural off-farm income plus income earned off the household's own farm but perhaps on other households' farms.

terms of income at any rate, as this would reduce estimated household incomes (which as already discussed appear to be quite reasonable) and the estimated proportion of income from non-farm sources is therefore unlikely to fall below 50%.

Where then can this non-agricultural labour demand come from? There are three possible sources:

1. transfers and payments for labour for tradable goods and services not included in the farm model (for example, this could include sale of livestock products or crafts, income from gold panning, or wages from non-local employers such as NGOs or the national extension agency)
2. local purchases of locally produced, non-tradable goods and services (such as carpentry or sewing products or natural resources exploited for cash income purposes). The extent of this will be limited by available rural income and the proportion of that income spent on non-tradables.
3. exploitation of natural resources for own consumption (see, for example, Cavendish 2000)[32].

We can examine these issues in more detail by multiplying the model income estimates for the different farm household types by the estimated number of households in each zone to obtain aggregate estimates of overall income flows, within what we term the informal rural economy (IRE). Estimation of income and expenditure flows within the IRE and between it and the wider national economy (and the rest of the world) requires (in addition to the information generated by the household models), an estimate of the proportion of household expenditures on tradables and non-tradables[33]. Table 3.6 present estimates of income and expenditure flows within the IRE assuming that tradables account for 75% and 60% of household expenditure in NR1-3 and NR4-5 respectively [34]. The table also presents two alternative sets of estimates for each zone, with the second set allowing for 25% of crop marketing margins to be retained in the informal rural economy as part of non-farm income. The latter estimates from table 3.6 are used in figures 3.2 and 3.3, which provide a schematic diagram of these income flows for the two zones. The rural economy included in this analysis includes smallholder farming activities and household incomes for the range of household types included in our typology and models. Non-farm rural activities are included in terms of their demand for smallholder household labour or for goods or services produced by such labour.

[32] Including this third category in this list suggests that the returns from such activity are comparable to those from the other activities in the list. In fact, there are reasons to believe that returns from exploitation of natural resources for own consumption may be considerably lower than other off-farm uses of labour (J.Stack, *pers.comm.*). A potentially interesting modeling scenario that we have not yet tried is to restrict off-farm labour *hire* further than is currently the case in the base scenario, but to allow unlimited use of labour for exploitation of natural resources, at much lower returns.

[33] This determines the value of goods imported into the IRE for domestic consumption, and - allowing for income and expenditure flows on crops, inputs and remittances – transfers and payments to local labour for tradable goods and services not included in the farm model, as described under (1) above.

[34] In this analysis we consider together income from sale of locally produced, non-tradable goods and services and income from exploitation of natural resources for own consumption, as in the household models, while recognising that this may lead to some over-estimation of labour exchanges and income.

Table 3.6 Aggregate Informal Rural Economy Flows, Z$ Millions

	NR1-3		NR4-5		Total	
Crop marketing labour demand	0%	25%	0%	25%	0%	25%
Total net income	4,253	4,253	4,816	4,816	9,069	9,069
Net farm income	1,707	1,707	1,324	1,324	3,032	3,032
Non own farm income	2,546	2,546	3,492	3,492	6,038	6,038
Of which non-agric income	2,342	2,061	3,423	3,249	5,764	5,309
Staple food expenditure	764	764	1,020	1,020	1,783	1,783
Other expenditure	3,490	3,490	3,796	3,796	7,286	7,286
% other expenditure on tradables	75%	75%	60%	60%		
Tradables expenditure	2,617	2,617	2,278	2,278	4,895	4,895
Labour Account						
Total labour sales	1,664	1,664	2,370	2,370	4,034	4,034
Crop marketing labour		281		174		455
Farm labour purchases	204	204	69	69	273	273
Non-tradables labour & rental income	872	872	1,518	1,518	2,391	2,391
Domestic labour demand	1,077	1,358	1,587	1,762	2,664	3,119
Required transfers & labour 'exports'	587	306	783	608	1,370	915
Rest of the World Incomings (exports)						
Cash crop sales	1,823	2,068	1,248	1,416	3,071	3,484
Credit in	0	0	0	0	0	0
Remittances	882	882	1,122	1,122	2,004	2,004
Labour exports / transfers	587	306	783	608	1,370	915
Crop marketing labour		281		174		455
Total exports	3,292	3,257	3,152	3,146	6,445	6,403
Rest of the World Outgoings (imports)						
Input purchase	1,008	1,008	475	475	1,483	1,483
Tradable purchases	2,617	2,617	2,278	2,278	4,895	4,895
Net Maize purchase	-333	-368	399	393	66	25
Total imports	3,292	3,257	3,152	3,146	6,445	6,403
Maize sales	673	708	115	121	787	829
Maize purchases	340	340	514	514	854	854
Net own farm income as % of net income	40%	40%	27%	27%	33%	33%
Off own farm income as % net income	60%	60%	73%	73%	67%	67%
Non-agric income as % of net income	55%	48%	71%	67%	64%	59%
% Hired our labour 'exported'	35%	18%	33%	26%	34%	23%
% Hired out labour local	65%	82%	67%	74%	66%	77%
% Hired out labour local farm	12%	12%	3%	3%	7%	7%
% Income from local services	21%	21%	32%	32%	26%	26%
% Income from labour 'export'	14%	7%	16%	13%	15%	10%
'Driver' income or demand	3,381	3,381	3,297	3,297	6,678	6,678
'Driver' income as % of total	79%	79%	68%	68%	74%	74%
'Supporter' income or demand	872	872	1,518	1,518	2,391	2,391
Agriculture as % of 'driver' income	57%	65%	42%	48%	49%	56%
Subsistence as % staple consumption	56%	56%	50%	50%	52%	52%
Subsistence as % net income	10%	10%	10%	10%	10%	10%
Staple consumption as % net income	18%	18%	21%	21%	20%	20%

Following through these calculations in Table 3.6 we find that local non-farm labour demand accounts for 53 to 70% of the total labour market in NR1-3 in value terms and between 65% and 70% of the total labour market in NR4-5, depending upon the extent to which crop marketing

generates labour demand[35]. This means that in NR1-3 labour 'exports' (remuneration for semi-skilled and skilled labour working, for example, as government, NGO or private sector employees in education, services, or estate agriculture, and food for work or selling charcoal or firewood to urban people) account for between 20 and 35% of labour earnings and for around 10% of total income[36]. Equivalent figures for NR4-5 are 25 to 30% of labour earnings and around 15% of total income gained from labour 'exports'. Hired smallholder farm labour demand accounts for around 12% of the total labour market value in NR1-3 and only 3% in NR4-5.[37,38].

Figure 3.2 The Informal Rural Economy, NR1-3 (income flows in million Z$)
(percentages of total income)

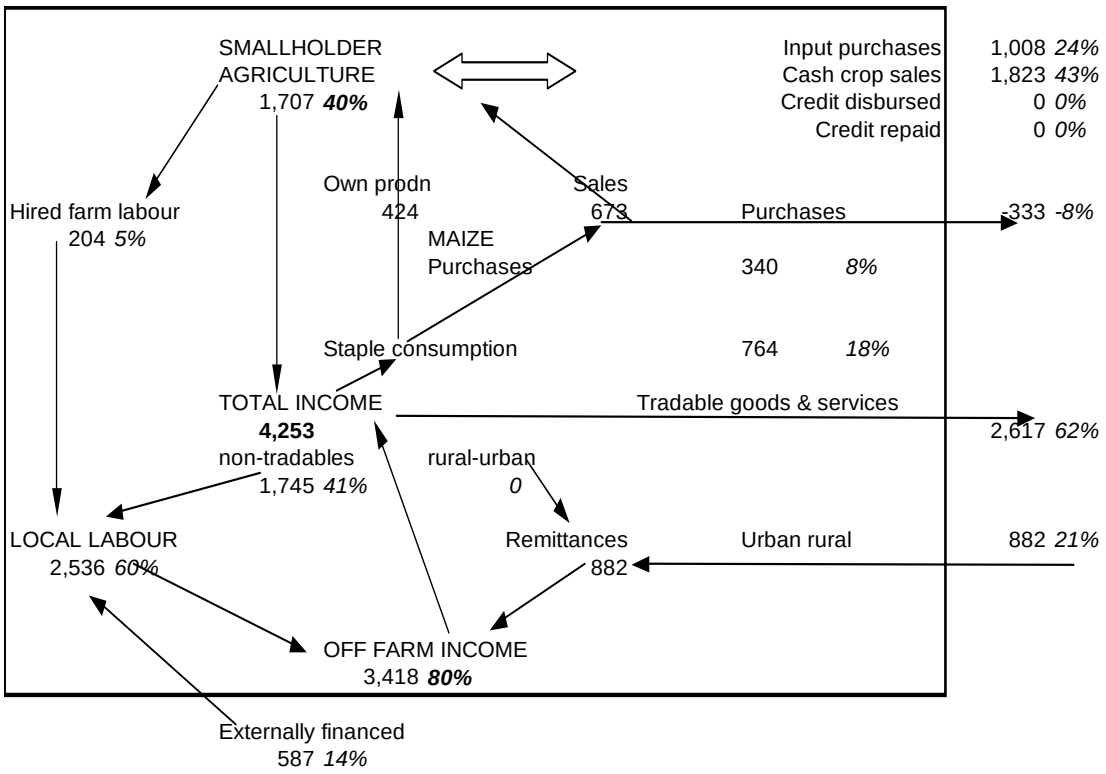


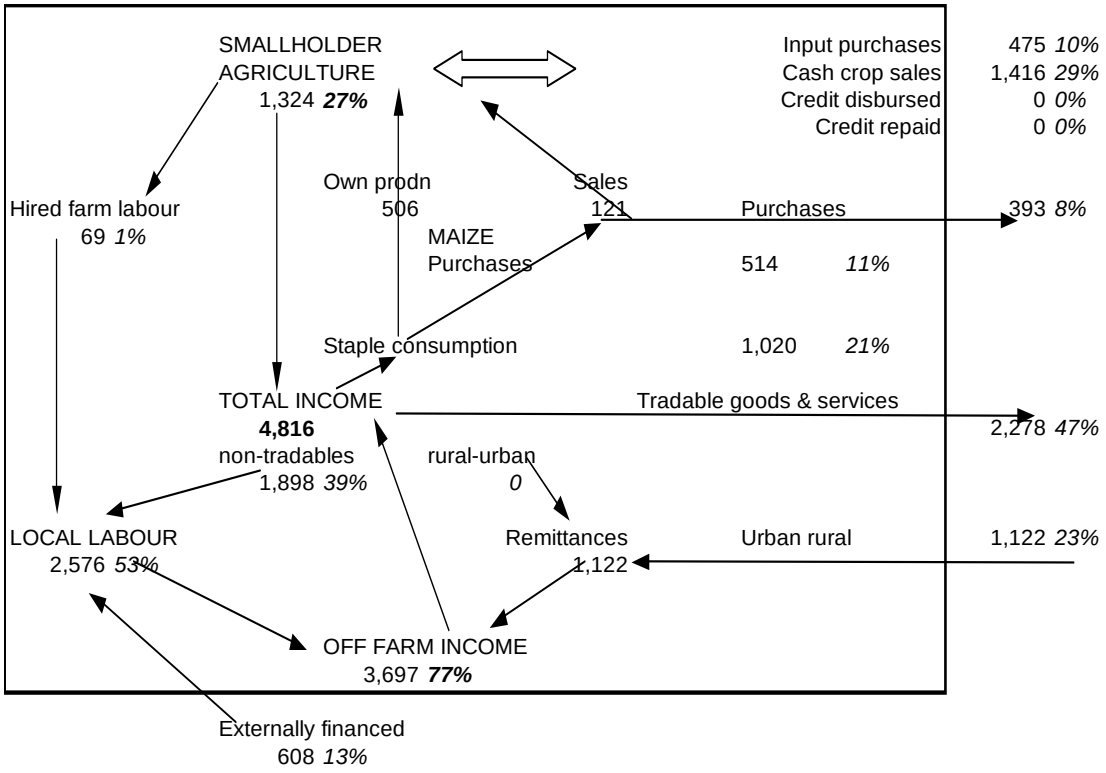
Figure 3.3 The Informal Rural Economy, NR4-5 (income flows in million Z$)
(percentages of total income)

[35] It should be noted that these proportions are in values, and the proportion of hired days used for farm labour would be considerably higher, due to its low wage relative to skilled and semi-skilled labour.

[36] The lower figures are probably closer to reality, since these allow for some income from local crop marketing, an important income source for poor households during the cropping season.

[37] The proportion of labour demand accounted for by farm labour demand will of course vary between seasons.

[38] As argued earlier some of the income attributed in the model to hiring out labour is likely to come from natural resource based activities (such gathering firewood, wild foods, thatching grass, etc). Only a very small part of this is likely to be 'tradable' in the sense that its products are exported to non-rural households, and it is therefore effectively allowed for within demand for non-tradable labour services in figures 3.2 and 3.2, and does not change the basic structure of the economy presented in figures 3.2 and 3.3.



However, these figures demonstrating the high proportion of income derived from non-farm sources do not provide a true picture of the importance of the agricultural sector for two reasons. First, the model does not attempt to include income from livestock production or small scale vegetable production. Inclusion of these would raise the relative importance of agriculture. More fundamentally, however, much of the non-farm income is itself dependent on labour demanded in the supply of services to households who have derived a significant part of their income from agriculture. This becomes clear if we make a distinction between what we shall term 'driver' and 'supporter' income sources (and the demand they generate) (see Poulton and Dorward 2003). 'Driver' income (and demand) is generated by production of tradables (cash crops and externally financed employment for example), remittances and production of high average budget share non-tradables). 'Supporter' income (and the demand it generates) arises from providing local, non-tradable goods and services to satisfy demand arising from driver and supporter income through multipliers and linkages (see Dorward *et al.* 2001**,** for a discussion of multipliers, linkages and budget shares in the growth of rural economies.

Table 3.6 shows that in our reconstruction of the smallholder rural economy 'driver' income (net farm income, agricultural marketing income, on-farm labour hire, labour exports and remittance income) accounts for just under 80% of total net income in NR1-3 and just under 70% in NR4-5. Smallholder agriculture accounts for around 60% of this driver income in NR1-3 but only 45% in NR4-5). The remaining driver income is derived from remittances and from labour 'exports', made up of formal and informal employment and transfers. Principal sources of employment will be commercial agriculture and rural non-farm enterprises producing tradables (firewood, charcoal, crafts, etc), and government and NGO activities, the latter paying employees who provide services to and on behalf of these organisations (for example teachers, extension staff, health workers, etc) and also proving transfer payments to the wider rural population (through food for work, etc). Important though remittances and government and NGO expenditure may be in providing welfare services and support to rural people, and in developing and supporting the institutional environment and other conditions necessary for rural growth, increases in these cannot be considered as local sustainable growth drivers in the rural economy. It is then becomes an empirical question as to

what proportion of the 'labour exports' is made up of employment in agricultural and non-agricultural enterprises producing tradables. If, for the purposes of argument, the proportion is 50%, then smallholder farm income would account for around 90% and 80% of the potential growth stimulating income in NR1-3 and NR4-5 respectively. Rough though these figure may be, they demonstrate that even where farm income is a small proportion of rural incomes (30% to 40% estimated here), this does not mean that it is unimportant in the rural economy and in rural growth strategies: smallholder agriculture may still be by far the dominant local activity with potential to drive economic growth. Taken together with earlier conclusions about the differing potential for smallholder agricultural growth in the NR1-3 and in NR4-5, this conclusion offers hope and a stimulus for greater efforts in promoting smallholder agricultural growth in NR1-3, whereas for NR4-5 it emphasises the great difficulties in identifying strategies for growth and poverty reduction. Here longer term poverty reduction requires improved access for poorer households to migrant employment opportunities.

4 Conclusions and Lessons

The primary purpose of the work described in this paper was to address strategic, operational and intervention questions regarding policy for pro-poor agricultural growth. We conclude by briefly reiterating the principle findings from this paper as regards first the methodological approach used in this paper and second the policy insights gained regarding opportunities and constraints facing poor rural households such as those found in communal areas in Zimbabwe.

4.1 Methodological lessons

This study constructed a programming model of farm/household livelihoods in communal areas in Zimbabwe by adapting an existing model from Malawi. This approach economised on modelling resources but, with appropriate modifications to the basic structure of the model, has generated broadly useful results, although of course there is still room for improvement and further development of the Zimbabwean model. This suggests that is could be useful to further explore this approach of modifying a basic programming model to match specific conditions. The use of a standard programming model structure is well suited to analysing problems with patchy data and non-standard economic behaviour as a result of the prevalence of imperfect markets.

An important difference between the Zimbabwean and Malawian methodologies was in the construction of the farm/household typology. Whereas in Malawi a national household survey allowed the use of cluster analysis to develop the typology, such a data set was not available when needed for this study, and a more structured typology was developed drawing eclectically from a number of different data sources. Again, this appears to have been broadly successful, and represents a pragmatic approach to household classification where this cannot be developed empirically from a single data set.

A key methodological issue that arose in the construction and validation of the Zimbabwean farm/household models concerned the structure and operation of the labour market. Whereas in Malawi it had been possible to model this in terms of a clearing wage, in Zimbabwe the divergence between off-farm wage rates and returns to farm labour highlights the importance of social relations in determining access to and returns from off-farm employment. Although off farm employment is critical to the welfare of the poor, very little information could be found on this topic.

4.2 Insights into farm/household livelihoods and pro-poor policy

The models highlight a number of features of farm/households which are of theoretical and of practical policy interest.

1. Although there are no households that show strong backward sloping supply curves for labour and maize, the poorer households in both NR1-3 and NR4-5 face severe working capital constraints prior to harvest. However, with relatively high wage rates in off-farm employment, households are generally better employed hiring labour out when they can (rather than employing it on their own farms), and hence although higher wage rates and lower maize prices do ease cash and food stock constraints during the cropping period, this does not generally lead them to increase their investment in on farm labour.
2. Increases in maize prices only provide direct benefits to better off households, and in NR4-5 the number of households that benefit from increased maize prices is very limited, as is the extent of their benefit. In NR1-3 poorer households may benefit from second round effects (as a result of (a) increased on farm labour demand from higher maize production and (b) a general stimulus to the economy), but in NR4-5 the very limited response to and gains from higher maize prices mean that these second round effects are likely to be very limited.
3. Higher wages lead to direct, first round increases in incomes for the able bodied poor, as well as second round effects through the labour market (as a result of production and, more important, consumption linkages) and hence to reductions in poverty.
4. A general increases in commodity (crop) prices offers more immediate broader benefits than an increase in maize prices alone, as for a number of households extra income from cash crops outweighs losses from higher purchase prices of maize. However, the ability of poorer households to respond to and benefit from higher prices by expanding production is limited by their limited access to capital (or credit) and to land. Unless these supply response constraints are addressed they will be restricted to capturing second round benefits from increased demand and wages for labour.
5. In both NR1-3 and NR4-5 the models demonstrate the importance to the rural poor of both own-farm and non-farm activities. While non-own-farm activities and income are very important to the direct livelihoods of the poor (accounting for around 70% of income for most poorer households), smallholder agriculture is still the most important sector underpinning the rural economy, with remittances coming a fairly close second in NR4-5. Smallholder agriculture plays a critical role in promoting household food security and in directly and indirectly tightening labour markets (holding up wages and employment opportunities).
6. In NR1-3, where agricultural potential is higher and there is a greater likelihood of second round wage effects from agricultural growth, promotion of institutional and labour demanding technology changes is a viable poverty reduction strategy. In NR4-5, however, achieving such change is both more challenging and will have much more limited impact. Agricultural development can and should play an important role in improving food security, and this paper has not considered growth opportunities from livestock production, but the scope for these is limited and it is very difficult to identify large scale pro-poor growth drivers within the rural economy: large scale pro-poor growth in NR4-5 is much more likely to be achieved by policies that stimulate labour demanding growth elsewhere in the national economy and improve access to national and international migrant labour opportunities (for example through improved education and communications and reduced barriers to seasonal and longer term movement of people).
7. A broader methodological issue for policy analysis is the importance of considering market and sectoral linkages and economic structures when examining opportunities and constraints facing rural livelihoods and the crafting of policies aimed at addressing these.

References

Brooke, A., Kendrick, D., Meeraus, A. and Raman, R. (1998). GAMS: A User's Guide. Wahington DC, GAMS Development Corporation.

Bryceson, D. (1999). "African Rural Labour, Income Diversification and Livelihood Approaches: A Long-Term Development Perspective." Review of African Political Economy **26**(80): 171-189.

Bush, J. (2003). Contribution to Forum for Food Security in Southern Africa, Vulnerability E conference.

Cavendish, W. (2000). "Empirical Regularities in the Poverty-Environment Relationship of Rural Households: Evidence from Zimbabwe."

Central Statistical Office (1998). Poverty in Zimbabwe. Harare, CSO.

Central Statistical Office (2001). Agriculture and Livestock Survey in Communal Lands 2000. Harare, Central Statistical Office.

DFID (1999). Zimbabwe: Country strategy paper 1999. London,, Department for International Development.

Dorward, A. and Kydd, J. (2002). The Malawi 2002 Food Crisis: The Rural Development Challenge. Paper presented at 'Malawi after Banda: perspectives in a regional African context', a conference to mark the retirement of John McCracken, 4-5th September, Centre of Commonwealth Studies, University of Stirling.

Dorward, A., Moyo, S., Coetzee, G., Kydd, J. and Poulton, C. (2001). Seasonal finance for staple crop production: problems and potential for rural livelihoods in sub Saharan Africa. Working paper, DFID Policy Research Programme project 'Diverse income sources and seasonal finance for smallholder agriculture: applying a livelihoods approach in South Africa'. Wye, Imperial College.

Dorward, A. and Parton, K. (1997). "Quantitative whole farm models and embedded risk in complex, diverse and risk prone agriculture." Quarterly Journal of International Agriculture **36**: 317-330.

Dorward, A. R. (1999). "Modelling embedded risk in peasant agriculture: methodological insights from northern Malawi." Agricultural Economics **21**(2): 189-201.

Dorward, A. R. (2003). Modelling poor farm-household livelihoods in Malawi: lessons for pro-poor policy. Wye, Ashford, UK, Centre for Development and Poverty Reduction, Department of Agriculutral Sciences, Imperial College London.

Dorward, A. R., Kydd, J. G., Morrison, J. A. and Urey, I. (forthcoming). "A Policy Agenda for Pro-Poor Agricultural Growth."

Ellis, F. (1998). "Household strategies and rural livelihood diversification." Journal of Development Studies **35**(1): 1-38.

Fafchamps, M. (1992). "Cash Crop Production, Food Price Volatility and Rural Market Integration in the Third World." American Journal of Agricultural Economics: -99.

Jayne, T. and Chisvo, M. (1991). "Unravelling Zimbabwe's Food Insecurity Paradox." Food Policy **16**(5): 319-329.

Jayne, T. S. (1994). " Do High Food Marketing Costs Constrain Cash Crop Production? Evidence from Zimbabwe." Economic Development and Cultural Change **42**(2): 387-402.

Poulton, C. (2002). Derivation of the Zimbabwe Communal Household Typology, 1996: Draft. Wye, mimeo: Imperial College London, Department of Agricutural Sciences.

Poulton, C., Davies, R., Matshe, I. and Urey, I. (2002). A review of Zimbabwe's agriculutral economic policies: 1980 - 2000. Working paper, Institutions and Economic Polices for Pro-Poor Agricultural Growth. London, Imperial College.

Poulton, C. and Dorward, A. (2003). The Role of Market Based Economic Development in Strengthening Food Security. Paper prepared for the ODI Southern Africa Forum on Food Security, June 2003. London, Overseas Development Institute.

Reardon, T. (1998). Rural non-farm income in developing countries. The State of Food and Agriculture 1998. FAO. Rome, Food and Agriculture Organisation.

Smith, L. and Urey, I. (2002). Institutions and economic policies for pro-poor agricultural growth: India literature review. Working paper, Institutions and Economic Polices for Pro-Poor Agricultural Growth. London, Imperial College.

Toulmin, C., Leonard, R., Brock, K., Coulibaly, N., Carswell, G. and Dea, D. (2000). Diversification of livelihoods: evidence from Ethiopia and Mali. Research Report. Brighton, Institute of Development Studies. **47**.

Weiner, D. (1988). Land and Agricultural Development in Zimbabwe. Zimbabwe's Prospects: Issues of Race, Class, State and Capital in Southern Africa. C. Stoneman. London, Macmillan**:** 63-89.

World Bank (1995). Zimbabwe: Achieving Shared Growth. Washington D.C., World Bank.

World Health Organisation (2000). Epidemiological Fact Sheet on HIV/AIDS and Sexually Transmitted Infections: Zimbabwe. Geneva., World Health Organisation.

Appendix 1: Data Sources

Household Typology

1992 census
Central Statistical Office "Agriculture and Livestock Survey in Communal Lands 2000"

ZDHS 1994

Ministry of Lands, Agriculture and Rural Resettlement "Annual Report of Farm Management Data for Communal Area Farm Units" 1989-90, 1990-91, 1991-92

Miscellaneous local surveys and stylised facts!

Crop Budgets

Ministry of Lands, Agriculture and Rural Resettlement "Annual Report of Farm Management Data for Communal Area Farm Units" 1989-90, 1990-91, 1991-92 (input-output relationships)

Stack, J (1997,1998) "Liberalised Markets and Rural Households, Briefs 1-4" (prices, unskilled wage rate)

Authors' unpublished data on cotton production (2002) and horticultural production (2001) (input application rates)

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