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- Thesis

**ANCHORED SCORING AND CONTINGENT VALUATION:
ESTIMATING THE VALUE OF MULTIPURPOSE TREE
RESOURCES IN ZIMBABWEAN COMMUNAL AREAS**

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ABSTRACT

That residents of Zimbabwe's Communal Areas (CAs) obtain a variety of goods and services from their natural woodlands has long been recognized. Little was known however, of the value or preferences of CA residents for these goods and services. This paper describes a study, carried out in mid-1991, to elicit the preferences of residents of CAs for the goods and services they derived from trees. A new approach to eliciting preferences and establishing monetary values for the non-market goods and services was developed and administered to a total of 369 households in three CAs. Scores given to tree-derived goods and services were indexed to an anchor (a borehole) for which a willingness to pay (WTP) estimate was elicited. A similar instrument, but without the WTP questions, was administered to 39 professionals involved in research, management, or administration of indigenous woodlands.

Of the goods and services derived from trees CA residents valued fuelwood, farm and household materials, inputs to crop production, animal feed and ecological services most highly. Mean capital value to a household of the tree-derived goods and services was Z\$1678. Using a 4% discount rate this capital could yield average annual household incomes of between 45 and 60% of the average incomes derived from agricultural activities. Differences in values between residents in high and low tree cover sites were used to estimate the per household loss in capital value of reductions in tree cover. These amounted to about Z\$700 per household or about 50% of the mean total value in high tree cover sites.

Professionals assigned a higher total value to tree derived goods and services than

did CA residents. Professionals and CA residents also assigned different values to several of the categories of tree derived goods and services.

The results had a number of implications for research and policy. Indigenous woodlands provide a significant source of household income whose value is not reflected in markets. Lack of understanding of the productivity of indigenous woodlands as well as the poor understanding of the impacts of management on woodlands were seen as major factors inhibiting their efficient and sustained use. Research, management and policy need to focus on enhancing the ability of CA residents to effectively manage their woodlands. This objective requires that researchers develop; a) a clear understanding of the values, needs and objectives of CA residents; b) reliable technical knowledge on the growth, production and reproduction of indigenous woodlands; c) a clear understanding of the institutions controlling the access to, and the use of, indigenous woodlands in the CAs of Zimbabwe.

INTRODUCTION

The importance of trees to Zimbabwe's Communal Area (CA) residents as multipurpose resources providing a variety of goods and services has been recognized for some time (Campbell *et al.*, 1993; Bradley, 1990; Grundy *et al.*, 1993; Swift *et al.*, 1989; Wilson, 1989a;b). To facilitate and ensure the sustainable utilization of these woodland resources by CA residents, policies and management practices need to be developed that 1) are consistent with the preferences of CA residents for the goods and services provided by trees, and 2) take account of the impact of local use practices on the tree resource base. The relative preferences of CA residents for the goods and services they obtain from indigenous woodlands has, however, not previously been ascertained.

A major problem faced when attempting to identify the relative preferences of CA residents for the goods and services they derive from trees is the lack of organized markets for most of the goods and services which trees provide. Organized markets are a major mechanism for identifying the values and preferences of individuals and society. Apart from the obvious case where goods are not traded in organized markets, markets do not necessarily reflect the true preferences or values of society where the property rights governing access to resources are non-exclusive (Randall, 1983). Access to tree resources in the smallholder sector of Zimbabwe is governed by a mixture of private and *res communis* property rights (Wilson 1989a). Rights of exclusion for tree resources operate at the level of the individual and the community. Many goods and services that trees provide are not traded in organized markets (e.g., browse, erosion control) or may be non-rival (i.e., their consumption by one individual does not reduce the availability for

another, for example the spiritual aspect of trees) or congestible goods (i.e., they are non-rival up to a level of use whereafter they become congested). Shade, for example, would be a congestible good.

In the absence of organized markets, an intuitively appealing approach to revealing the preferences of individuals and society is the use of contingent valuation methods (CVM). These techniques use a hypothetical market situation to obtain bids from individuals that represent their maximum willingness to pay (WTP) for a commodity (Davis, 1963). In order for the results to be accepted as valid and useful, CV studies must demonstrate that the values expressed by respondents are a true measure of the worth of the commodity being valued. The National Oceanic and Atmospheric Administration (NOAA) Panel on CVM (Arrow *et al.*, 1993) was established to make recommendations as to whether CV studies could yield reliable information on passive use¹ values. Despite the positive recommendations of this panel there is still vigorous debate about whether CV studies are capable of providing valid information on passive-use values (Bishop and Heberlein, 1979; Bishop *et al.*, 1983; Bjornstad and Kahn, 1996; Brookshire and Coursey, 1987; Hausman, 1993; Knetsch and Sinden, 1984; Mitchell and Carson, 1989). Much of this debate is not relevant or only peripherally relevant to the Zimbabwean study, where the CVM was used to derive a WTP for a durable good that had an observable market price. Many of the arguments in the CV debate are related

¹ The NOAA panel was set up to "evaluate the use of CVM in determining nonuse values" (Arrow *et al.*, 1993). Non-use values reflect the satisfaction individuals might derive from the existence of a good or service, even if they never intended to use it. Arrow *et al.*, (1993) use the term passive use value as being synonymous with non-use value.

to passive-use values and not to commodities with market values. For a recent review of the methodology and underlying theory of CVM the reader is referred to Bjornstad and Kahn (1996).

The objectives of this study were; 1) to identify the relative preferences of CA residents for the goods and services they obtained from trees and then; 2) to estimate the values of these commodities in a common currency. In carrying out the study we also attempted to make some informed observations on how these values might change under different use scenarios.

The next section of the paper, the methods section, begins with a brief review of the major criticisms of CV and a review of applications of CVM to valuing natural resources in developing countries. Thereafter, the justification for selection of study sites as well as some background information on these sites is presented. In this study a new approach to eliciting preferences and assigning monetary values to non-market goods and services was developed. The methods, including tests for validity and reliability, are therefore described in detail. The results and discussion section of the paper begins with a presentation of tests of the validity of the CV results. The preferences and values of CA residents for the goods and services they derive from woodlands are then discussed, followed by a comparison of the values professionals attributed to woodland goods and services from a societal perspective. Research and policy implications are discussed in the final section of the paper.

MATERIALS AND METHODS

Introduction

A combination of a scoring method, adapted from Sinden and Worrell (1979, p206) and a CVM were used to estimate the values of individuals for goods and services derived from trees. Since this is a new approach to eliciting preferences and estimating value, the methods are described in detail. A bounded scoring method was developed to identify the relative preferences of individuals for categories of goods and services they obtained from trees and also for two anchors (a borehole and a latrine²). A CVM was then used to estimate the value (WTP), to individuals, of the main anchor (the borehole). Scores of each category of tree derived goods and services were then indexed to the score of the main anchor. Using the indexed scores and the value of the main anchor the value of each category of tree based goods and services was estimated. Each of these steps is discussed in greater detail after a discussion of the CV approach.

Using a commodity with a market value as the anchor but then using an elicited value of that commodity to derive the values of the goods and services of interest, had several advantages. Firstly, the validity of the WTP value could be checked against the market price. Secondly, market prices do not necessarily reflect the value of a commodity to all members of a society. For some agents, market prices underestimate value and for others market prices overestimate value. Market prices reflect the aggregate WTP and willingness to accept compensation (WTA) of transactions that

² A borehole is a tube well. In this paper all references to the borehole refer to both the tube well and the hand pump - a complete water delivery system.

occurred over the observed period of time. Only the values of those agents willing or able to make transactions in the market over the range of likely prices would be expressed in a market's price. By having individuals state their value (WTP) for the anchor it was possible to derive an estimate of the aggregate worth of the anchor for all agents of concern irrespective of their ability or willingness to trade in the market. For the purposes of this study this valuation was considered to be more useful than estimates based on the aggregate of transactions in a market, very few of which were likely to have occurred in the areas in which this study was conducted.

In using this approach it was assumed that individuals could order categories of goods and services in order of decreasing preference. It was also assumed that, with a limited number of points to allocate (i.e., a limited budget), individuals could express their relative preferences for each category of good and service by allocating points to reflect their greatest to least preference. It was hypothesized that, by standardizing the relative preference scores of each category of goods and services to the score of a commodity of known monetary value, reliable estimates of the true worth of each category could be estimated, using money as a common currency.

Trees are capital goods that, when used non-consumptively, provide income streams to users in the form of goods and services. A capital good (the borehole) was therefore used as the anchor in this study. To convert the capital value of trees into annual income streams it was, however, necessary to estimate household interest rates. It was not the purpose of the present study to investigate the interest rates of households in the study sites. The average increase in the consumer price index for the period 1985 to

1993 was used as an indicator of the likely, lower bound on the interest rates of CA households.

The contingent valuation approach

The CV approach remains highly controversial, both from a theoretical as well as a methodological perspective. A panel of economic experts, led by Kenneth Arrow, was set up by NOAA to evaluate the use of CVM in determining passive-use values. The recommendations of the NOAA panel (Arrow *et al.*, 1993) have become guiding principles for the application of CVM, designed to minimize the possibility of biased results (Portney, 1994). At the end of the methods section of this paper the seven major methodological recommendations of the panel are used to evaluate the present study's performance.

The theoretical criticisms of CV remain none-the-less. The rationality assumption of consumer choice theory postulates that "usually, though not always, it is reasonable to suppose that more of something regarded as good is better so long as an individual is not satiated. This is in general translated into a willingness to pay somewhat more for more of a good" (Arrow *et al.* 1993). The results of several CVM studies, however, have produced results inconsistent with this postulate, often referred to as the "scope effect" (Desvouges *et al.*, 1993; Diamond *et al.*, 1993; Kahneman and Knetch, 1992).

Defendants of the CV approach claim these studies were technically defective or incorrectly analyzed (Hanemann, 1996), but Arrow *et al.* (1993) suggest that the "scope effect" is a serious problem that CV practitioners need to address. Consistency with

theory becomes particularly important when no real markets exist to test the values derived in hypothetical markets. In these cases theory provides a major means of testing the validity of hypothetical results (Mitchell and Carson, 1989). In the present study, where an actual market result was available for validation purposes, the issue of theoretical consistency was less important. Faced with the question of whether, when the data do not conform to the expectations of existing theory, we discard the data or the theory, economists have seemed remarkably reluctant to adopt the Popperian norm of discarding the theory. The theory of rational choice has, however, been subject to consistent criticism from eminent economists and psychologists alike (Arrow, 1986; Tversky and Kahneman, 1986; Heiner, 1983; Sen, 1977; Simon, 1955). Simon (1986) put it most forcefully when he recommended:

“..that we stop debating whether a theory of substantive rationality and the assumption of utility maximization provide a sufficient base for explaining and predicting economic behavior. The evidence is overwhelming that they do not.”

Arrow (1986) has dismissed the assertion that “..a theory of the economy must be based on rationality..”. Given this debate within the field of economics itself it was not considered particularly useful, from the perspective of this study, to use theory to test the results when empirical data were available. Consistency with rational choice theory was seen as being a complementary test but not a deciding test of the results of this study.

Studies that use CVM to derive values of natural resources in developing countries are rare. The only example found in the literature (Gunatilake *et al.*, 1993)

provided insufficient information about the approach used, either to evaluate the results presented or to compare the methods with those used in the present study. CV studies have been used more frequently in determining the WTP of potential consumers for water services (Singh *et al.*, 1993; Atlaf *et al.*, 1992; Whittington *et al.*, 1992; MEWRD, 1985). Griffin *et al.* (1993) provide one of the few examples of a study where ex post re-evaluation of the behavior of households was carried out after a WTP survey was administered. In 1988, as part of a study by The World Bank, Singh and colleagues (Singh *et al.*, 1993) carried out a study to determine the WTP of households, in the Indian state of Kerala, for piped water services. In 1991 Charles Griffin and colleagues (Griffin *et al.*, 1993) returned to the same households to establish which had opted to connect to the water system proposed in the 1988 studies. They found that the behavior of 91% of surveyed families was consistent with their intentions declared in the 1988 CVM survey. This carefully designed and executed study provides clear evidence of the validity of using CVM to establish consumer WTP for water services and adds weight to the claims of validity for the present study.

The methods to be used in the Zimbabwean survey had to take account of the fact that a large proportion of the respondents in the CAs were likely to have low levels of literacy and numeracy. The methods used therefore needed to be independent of literary ability. Consequently, simple and graphic methods of data collection were developed and are described in detail below. It was also recognized that, in some instances, individual values might be at odds with societal values. In an attempt to explore this expectation questionnaire instruments were administered, by mail, to senior civil servants, research

scientists and managers in the commercial sector.

Site and sample selection

Sites for investigation were selected to reflect differences in agricultural production potential and differences in the cover of trees in indigenous woodlands. These factors were hypothesized to be important determinants of an individual's values as was individual wealth. Three areas were selected for investigation to represent high (Mangwende), medium (Shurugwi) and low (Chivi) agro-ecological potential (Figure 1) based on the Zimbabwean classification of agro-ecological zones (Vincent and Thomas, 1960). Mangwende CA is in Natural Region IIa which is considered suitable for intensive agriculture. Shurugwi CA is in Natural Region III which is considered to be suitable for semi-intensive farming based on livestock production. Chivi CA is in Natural Region V which is considered to be suitable for extensive livestock and wildlife production (Table 1). All three sites are found on granite-derived alfisols and all three have the same potential climax vegetation, a miombo woodland dominated by *Brachystegia spp.* and *Julbernardia globiflora*. Estimated mean annual rainfall figures for these areas were obtained from the Department of Meteorological Services and from the climate data base of Booth and Stein (1990).

Figure 1. Location of study sites in relation to major urban areas, and natural regions of Zimbabwe

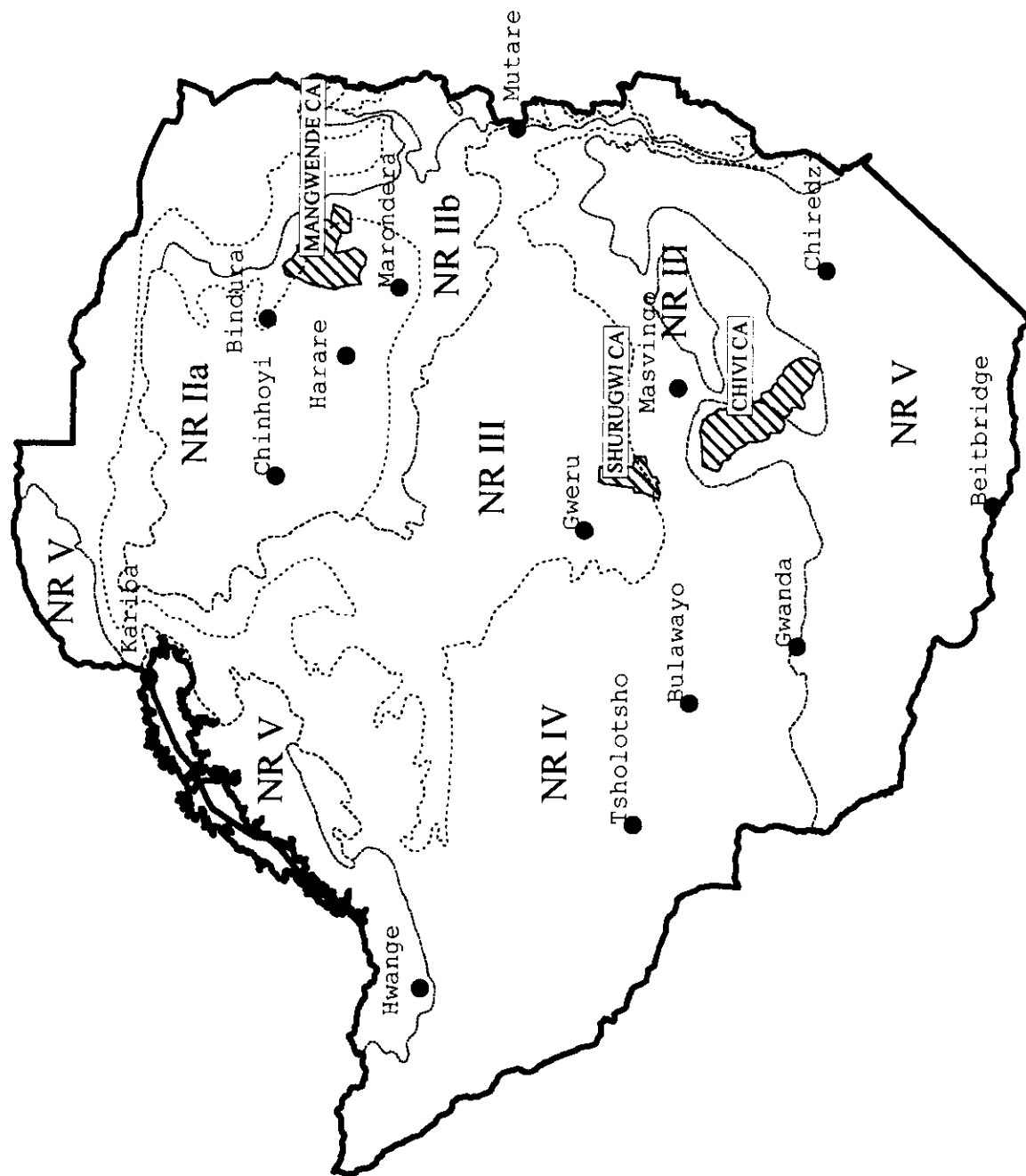


Table 1. Ecological and demographic characteristics of the three study sites.

	Mangwende	Shurugwi	Chivi
Natural Region	II(a)	III	V
Mean annual rainfall (mm) with years of record in parentheses ^a	852 (41)	692 (10)	572 ^c
Annual rainfall coefficient of variation (%)	32	41	nd
Population density in 1992 (people km ⁻²) ^b	68	59	46
Total number of households (1992) ^b	25610	8029	20492
Average growth rate of population between 1969 and 1992(%)	2.5	10.1	2.1

Source: a) Dept. of Meteorological Services; b) USAID-FEWS; c) Booth and Stein (1990), calculated estimate of mean.

Within each of these areas, one site with high tree cover and one with low tree cover were selected, based on the opinions of local residents. The relative wealth status of respondents was determined *a posteriori* using information collected in the background data section of the household questionnaire and the principal components analysis method used by du Toit *et al.* (1984). The wealth index largely reflects ownership patterns of livestock and agricultural equipment.

Questionnaire design and administration

Two questionnaire instruments were used. The first, the household questionnaire (Appendix 1), was administered in personal interviews, by trained enumerators, to the heads of randomly selected CA households. In total 359 households were sampled, comprising 0.7% of the total population of households in the three CAs. The second, the professional questionnaire, was mailed to selected professionals (n=39). The total

population of these professionals was not known but was unlikely to exceed 300.

The household questionnaire was designed to provide information on: a) the household and household members; b) the relative preference rankings and scores for classes of goods and services that households were likely to derive from woodlands and; c) estimates of the monetary value of the anchor used in the relative preference scoring of woodland goods and services.

The questionnaire used to estimate social values for woodland goods and services (the professional questionnaire) was designed to provide information on: a) the respondent, including the capacity in which they were employed; b) the perceptions of respondents on a broad range of questions about woodlands and their roles in CAs as well as for Zimbabwe as a whole; c) the perceptions of the respondents as to the relative importance of the goods and services provided by woodlands to Zimbabwean society. This latter information was sought in relation to areas falling into low production potential areas (NR IV and V) and high production potential areas (NR II and III).

The household questionnaire was field tested and extensively discussed at a half-day workshop of academics and professionals working in the fields of natural resources and agriculture. Problems or omissions that were identified, particularly missing categories of woodland goods and services, were incorporated into the final questionnaire.

The value of each category of tree-based goods and services was derived from information provided by respondents in two separate sections of the household questionnaire. Direct questions to establish the values of tree resources were considered

inappropriate due to; 1) the non-market nature of many of the categories of tree commodities; 2) the inexperience of most respondents in dealing with monetary valuations of tree resources and; 3) the difficulty of deriving sub-category values for resources which people may value as a "total resource" (Mitchell and Carson, 1989).

In the first section of the household questionnaire a bounded scoring approach (adapted from the scoring method described by Sinden and Worrell, 1979, p 206), was used to obtain scores for the relative preferences of respondents for each category of tree goods or services and the two anchors. Respondents were given 50 counters (i.e., points) to allocate among the categories of goods and services derived from woodlands as well as the two anchors. The fifty points represented the total utility derived from the categories of commodities that were identified as being provided by woodlands as well as that provided by the two anchors. Respondents had to allocate this "bounded total utility" among the categories of goods and services and the two anchors. This was done in the following manner. Cards with line drawings depicting categories of goods and services obtained from trees (n=10 categories, see Appendix 2, Table A2.1 for category descriptions) as well as cards depicting a borehole and a latrine were laid out and their meaning carefully explained to each respondent. Respondents were first asked to rank the cards, including the two anchors, to reflect the importance of each category of commodities as well as the two anchors. The enumerator noted the rank order and then gave respondents fifty match sticks and asked him or her to distribute these among the cards to reflect the relative importance of each category of commodities to the individual.

The second section of the household questionnaire consisted of two, open-ended, WTP and WTA questions and a single dichotomous choice (DC) question. For the first question the enumerator read a description of a hypothetical scenario to the respondent. In this scenario the respondent was offered the opportunity to join four other households to sink a borehole and install a hand pump. It was explained that the participating households would be guaranteed finding water, that they would have exclusive use of the borehole and that they would be able to obtain an interest-free loan to pay for their share of the borehole with repayments to be made over five years. The repayments were to be deducted directly from money they would receive from crop sales to government marketing agencies. Respondents were then asked to state what they would be willing to pay for their share of the borehole. These responses provided the open-ended willingness to pay (WTP) results used in subsequent analyses.

In the second question of this section, respondents were asked what compensation they would be prepared to accept from the government, if the government were to destroy the borehole they shared with four other households (in order to complete a construction project). Responses to this question yielded the willingness to accept compensation (WTA) results used in subsequent analyses. This scenario was also read to respondents to ensure consistency in the presentation of the hypothetical situation.

In the third question of this section of the household questionnaire a series of dichotomous choice (DC) questions were asked. The respondent was asked to choose between having a borehole shared with four other households and a series of five items decreasing in value from Z\$23000 to Z\$280 (see Table A2.2, Appendix 2 for

descriptions of these items). All monetary values are reported in Zimbabwe dollars (Z\$). In mid-1991, Z\$1.00 = US\$0.32.

In the last section of the household questionnaire, background information on the household and household respondent were collected. These data included details on the respondent (e.g., sex, age, years resident in area, years education), on the household (e.g., number of people, major crops grown, number of cattle and goats owned, ownership of assets, house type) and on the nature of household water supplies.

The questionnaire sent to researchers, administrators and other professionals (the “professional” questionnaire) was structured similarly to the household questionnaire but was administered by mail. A covering letter explained the nature of the research and what was expected of the respondent. In the first section of the questionnaire a Likert scale (Alreck and Settle, 1985) was used to establish the respondent’s beliefs about trees in the CAs. In the second section of the questionnaire the same categories of goods and services CA residents derived from woodlands and the same two “anchors” were presented. Respondents were asked to rank the 12 categories and then to score them with the sum of scores for all categories equaling 50. In the last section of the questionnaire, information on the respondent’s professional association and experience was sought.

Comparisons with NOAA recommendations

The seven major recommendations of the NOAA panel (Portney, 1994; Arrow, *et al.*, 1993) are shown in Table 2 with an evaluation of how the administration of the present study performed in regard to these recommendations. Overall, the study

described here satisfied five of the seven major recommendations made by the NOAA panel.

Table 2. Comparisons of NOAA panel recommendations with performance of the practices used in the present study.

NOAA Guidelines	Procedures used in the Zimbabwean CA survey.
1. Interviews in person rather than by telephone or by mail.	Interviewed household head personally. Expert survey done with mailed questionnaires.
2. Valuation scenario deals with a future, hypothetical event rather than a historical event.	Survey asked about WTP for a future, hypothetical, borehole installation.
3. Referendum format in which respondent "votes" on a benefit with a known price.	Open-ended WTP and DC formats used and found to yield results that were not different.
4. Interviewer begins with an accurate and understandable description of the benefit or program.	Interviewer described the exact scenario being valued, including the payment and property rights regimes.
5. Survey reminds the respondent that payment for the new program reduces other consumption.	Payment scenario used (that payments would be deducted directly from crop harvest payments by government authority or the household would be expected to pay in labour) had an implicit budget constraint.
6. Survey reminds the respondent that substitutes exist for the commodity in question.	No explicit reminders given. Explicit questions about alternatives were asked but after the CV questions.
7. Follow up questions to ensure understanding of the choices and to discover reasons for their answers.	No follow up questions asked but <i>a posteriori</i> tests indicated that understanding was good.

Source: Griffin *et al.* (1995); Portney, (1994); Questionnaire survey.

Where the present study did not satisfy the NOAA recommendations (items 6 and 7, Table 2), tests based on theoretical expectations were used to establish the study's conformity to NOAA recommendations. Whilst these are admittedly weaker than the explicit recommendations of the NOAA panel, they do provide some evidence for the performance of the current study.

Calculations and analysis

Points allocated to each category of tree goods and services were standardized against the points allocated to the borehole. Each category of tree commodity, as well as the category for the Blair toilet, were converted to units of "borehole equivalents" (i.e., the *numeraire* was in units of boreholes). These units were multiplied by the total value of the borehole implied from the respondent's expressed willingness to pay (WTP) for his or her share of the borehole (i.e. borehole value = 5 * stated WTP):

$$V_i = \frac{S_i}{S_{bh}} * (WTP_{bh} * 5)$$

Where;

V_i = the value, in Z\$, of the *i*th good or service;

S_i = the score given to the *i*th good or services;

S_{bh} = the score given to the borehole;

WTP_{bh} = the respondent's willingness to pay for one-fifth share in a borehole under defined conditions.

The value of a fifth share in a borehole, as expressed in the DC questions, was calculated in the following manner. The dollar value of a respondent's preference was taken to be the dollar value mid-way between the value of the lower and upper-valued good in the list. If a respondent preferred all the goods in the list to a fifth share in a borehole, then their value for the fifth share in the borehole was taken to be Z\$140, or half way between Z\$0 and Z\$280 (the value of the cultivator). If a respondent would

rather have had a fifth share in the borehole than any of the goods in the list then their value was set at Z\$22800 or the value of the tractor. These values placed a lower and an upper bound on DC choices.

Value data were log transformed for analysis using the following relationship: $\text{logged value} = \ln(\text{value}+1)$, where \ln was the natural logarithm. All means presented in the paper are geometric means.

Validity and reliability checks

The availability of estimates of the construction costs for the boreholes used as a *anchor* provided a marketed commodity with which to make direct comparisons of the values derived from respondents' WTP for a share in the borehole. Following Mitchell and Carson (1989), the overall validity of the elicited responses was considered to be a function of content, criterion and construct validity. These latter checks were used as additional checks of the validity of the estimates using market information.

To check that the content of the questionnaire was valid, and particularly the categories of tree goods and services, the questionnaire was circulated among professionals and colleagues for comment and discussion and reviewed in a half-day workshop. The questionnaire was also pre-tested in the field and respondents asked to identify categories that were missing.

The criteria used to establish the values to smallholder farmers of the goods and services they derived from woodlands were assumed to be valid if category scores for the Blair latrine, standardized against borehole scores, and multiplied by the value of the

borehole derived from respondents' WTP values, provided accurate indications of the expected costs of installing a Blair latrine. The actual costs of purchasing and installing hand boreholes and of building a Blair latrine were obtained from Blair Laboratories, Harare.

Construct validity (the degree to which the measure relates to other measures as predicted by theory) was established in the following manner: a) developing hypotheses as to expected theoretical relationships in the data (Mitchell and Carson, 1989; Sinden and Worrell, 1979) and determining whether the expected theoretical relationships were substantiated by the data; and b) using two different methods to measure respondents' perceptions of the value of a borehole and determining whether the different measures converged to the same result (Mitchell and Carson, 1989). The following hypotheses were tested to check the theoretical validity of the WTP results:

- 1) Mean WTP in the highest rainfall area would be less than the mean WTP in the lowest rainfall area;
- 2) Mean WTP of those whose water came from wells or boreholes would be less than the mean WTP of those whose water came from other sources.

The convergence of results was established by comparing the borehole values derived from the open-ended WTP question and the series of dichotomous choice (DC) questions.

To enhance the reliability of CVM estimates, Mitchell and Carson (1989) suggest the use of sufficiently large sample sizes (i.e. at least 600) and robust statistical techniques that guard against undue influence by outliers. Sample size selection was

determined by time and resource constraints and reflects the exploratory nature of the study. Wherever appropriate, medians as well as the means are presented to indicate the potential biases due to outliers. By using geometric means the effects of outliers is already much reduced.

RESULTS AND DISCUSSION

Tests of validity

Survey respondents who did not have access to a borehole were only willing to pay about two-thirds of the actual cost of installing a borehole (Table 3). This result was consistent with the expectation that market prices reflect the mean WTP of all those able or willing to pay at least that amount for a commodity. The values of those willing to pay less for a commodity than the market price are not reflected in the market price. We would therefore, expect market prices to be higher than values derived from stated WTP under the conditions used in this study.

Adopting the 6 percent interest rate used by the consultant in the Ministry of Energy, Water Resources and Development water tariff study (MEWRD, 1985), the capitalized willingness to pay for standpipe access was Z\$300; a figure that is similar to the WTP values derived in this study.

Table 3. Mean willingness to pay (WTP) for a fifth share in a hand borehole¹.

Statistic	WTP for one fifth share of borehole (Z\$)	One fifth of the actual costs of a borehole (Z\$) ²
Mean	248	370
95% CI	205 - 301	NA
Median	201	NA
Range of actual costs		324 - 414

1. Source: Household survey. WTP values for those respondents who did not, at the time of the survey, have access to a borehole.
2. Source: Blair Laboratories, Harare. The mean and likely range of a fifth of the costs of actually installing a borehole are included for comparison.

The value of a Blair latrine, as calculated from respondents' stated WTP for a fifth share in a borehole was very close to the expected cost of building the latrine (Table 4). The closeness of these results is indicative of the criterion validity of the elicited WTP values and suggests that the standardized scores, multiplied by the WTP for the borehole, do yield valid estimates of the values of other categories.

Table 4. Mean value for a Blair Latrine derived from open-ended WTP responses (n=357).

Statistic	Value of Blair Latrine estimated from WTP (Z\$) ¹	Actual cost of building a Blair Latrine (Z\$) ²
Mean	217	260
95% CI	169-277	NA
Range	NA	238-291

1. Source: Household survey.
2. The expected mean and range of costs of actually building a Blair latrine are included for comparison. Source: Blair Laboratories, Harare.

The similarity of borehole values derived from open-ended WTP and

dichotomous choice questions suggests the constructs used to establish these values were valid (Table 5). The difference between these two values and the WTA compensation values follows the trends frequently found in the literature (Mitchell and Carson, 1989). Mitchell and Carson (1989) suggest that, contrary to existing beliefs, WTP and WTA values could be expected to diverge significantly when there are few close substitutes for the goods in question. This is certainly true of boreholes in rural areas where, in terms of cost and quality, there are few close substitutes.

Table 5. Mean and median responses for open-ended willingness to pay (WTP) and dichotomous choice (DC) borehole valuations and willingness to accept compensation (WTA) for borehole loss.

	WTP (Z\$)	DC (Z\$)	WTA (Z\$)
Mean ¹	221 ^a	186 ^a	502 ^b
95% CI	195-252	164-210	440-575
Median	201	151	501
n	358	359	358

1. Dissimilar superscripts indicate means significantly different with $p < 0.001$. Source: Household survey.

The mean WTP in the high rainfall Mangwende area was significantly lower than that in the low rainfall Chivi area ($t=4.2$, $df=234$, $p<.001$) (Table 6). Given the single replication of each agro-ecological area in the survey design it is not certain that these differences were due to rainfall effects and not to site effects.

Table 6. Mean and median responses for open-ended willingness to pay (WTP) for a fifth share in a borehole in a high rainfall area (Mangwende) and a low rainfall area (Chivi).

Statistic	Mangwende (Z\$)	Chivi (Z\$)
Mean ¹	184	331
95% CI	130-217	272-402
Median	201	301
n	112	124

1. Means were significantly different at $p < 0.001$. Source: Household survey.

Mean WTP for those respondents whose water source was a well or borehole was Z\$200 (95% CI: 174 - 231, $n=282$) whilst for respondents whose water source was a dam, river or other source, the mean WTP was Z\$321 (95% CI: 245 - 422, $n=76$). These values were significantly different ($t=3.0$, $df=356$, $p=0.003$). Mean WTP did not differ between male and female respondents ($t=0.414$, $df=356$, $p=0.679$).

In summary, mean WTP for a fifth share in a borehole, of respondents who did not have access to a borehole at the time of the survey, was about Z\$250. This figure was about one-third less than the estimated market costs of building a borehole (Z\$370) and slightly less than the MEWRD (1985) estimated WTP for access to a standpipe (Z\$300). The lower WTP value found in the household survey was consistent with expectations.

A mean value for the Blair Latrine was estimated using the anchor. This estimated value was very close to the market cost of constructing a Blair latrine. Mean WTP for a fifth share in a borehole derived from open-ended questions and dichotomous choice questions were not different but the WTA estimate was considerably higher than

either WTP estimate. These findings were consistent with expectations. Mean WTP for a fifth share in a borehole was higher in the low rainfall site, and higher for those whose primary water source was other than a borehole compared to those whose primary water source was a borehole. Given these results the following null hypotheses were rejected:

1) CVM estimates of the value of the borehole to respondents were unreliable; 2) The scores assigned to categories of goods and services were not reliable reflections of the value of these goods and services to respondents.

The results of the survey were found to conform to expectations of construct and criteria validity and are therefore considered to accurately and reliably reflect the value of resources under consideration.

Values of goods and services provided by trees

The tree commodity categories appear to fit into three groups of importance. In the first group are the direct inputs to households (fuelwood and farm and household materials). In the second group are the inputs to production activities (crop inputs, animal feed and cash income) whilst the third group comprises most of the tree-related services (ecological services, shade, health, social services). In general, direct material inputs and inputs to major productive practices were the most valuable categories of commodities that households obtained from tree resources, with wood-based products being the most valuable (40% of the total value). Inputs to production were the next most valuable group, accounting for 24% of the total value. Ecological services accounted for 10% of the total value. Non-market goods and services (ecological services, social services and

shade) account for almost 20% of the total value of tree resources (Table 7).

Table 7. Mean values and 95% confidence intervals for values of categories of commodities provided by trees. Values calculated from stated WTP for a fifth share in a borehole. All values in Zimbabwe dollars (Z\$).

Goods and services ¹	Mean ²	95% CI	Median	Rank	% of Total
Fuelwood	373 ^a	306-467	500	1	22.23
Farm / house materials	290 ^b	235-370	400	2	17.28
Crop production	222	179-288	333	3	13.23
Animal feed	181	146-237	144	4	10.79
Ecological services	175	140-231	257	5	10.43
Food	136 ^c	111-180	200	6	8.10
Shade	102	84-137	150	7	6.08
Cash income	82	68-111	125	8	4.89
Health	71 ^d	59-97	100	9	4.23
Social services	46	40-65	47	10	2.74
TOTAL	1678	1368-2183	2256		100.00

1) See Table A2.1 for descriptions of categories.

2) Superscripts indicate that the mean is significantly different to the mean of the category below it.

a) $t=2.5$, $df=356$, $p<.05$; b) $t=2.3$, $df=356$, $p<.05$; c) $t=2.2$, $df=356$, $p<.05$; d) $t=3.2$, $df=356$, $p<.01$. Source: Own calculations based on Household survey data.

Except for food, there were no differences in the values assigned to categories of goods and services by male and female respondents. Male respondents assigned higher values to the food category than did female respondents (Mann-Whitney $U=17452.5$, $p=.008$).

If we assume a discount rate of 4 percent³ and convert the above capital value of resources to an annual benefit stream (using $A = C / (1+I)^n$, where A is the annual benefit stream, C is the capital value; I is the discount rate and n is the number of years), then the annual benefits derived from tree resources could be equivalent to about Z\$560 per

³ Over the period 1985 to 1993 the consumer price index in Zimbabwe increased by about 4% per annum.

household per year over a 30-year period. To establish the relative importance of these values and those presented in Table 7, they are compared to average annual incomes in the smallholder sector. Jackson and Collier (1991), in a national survey, estimated the mean annual household income from on-farm production (i.e. crop income and livestock income) for CA households to be Z\$422. ILO (1993) estimate an average household income from agricultural production of Z\$525. The 1991 equivalent incomes (adjusted using the lower income consumer price index) would be Z\$952 and Z\$1185. The Z\$560 worth of goods and services that households derived from trees would therefore be equivalent to between 47 and 59% of the average annual income households derived from agricultural activities. Tree resources thus make a significant contribution to the livelihood of smallholder farmers, in effect increasing their gross annual incomes by about 50%.

A clearer appreciation of the values held by smallholder farmers will facilitate greater understanding of their behavior with regards to resource consumption and technology adoption. For example, the value of fuelwood (Z\$373, Table 7) implies annual benefits of Z\$115 per household per year (assuming the four percent discount rate). Smallholder farmers could therefore be expected to be willing to pay (in cash or labour equivalents) up to Z\$115 per year to secure fuelwood supplies. With eucalyptus wood costing between Z\$35 and Z\$44 per ton to produce (Coopers and Lybrand, 1986) and the average household requiring about 5.5 t yr⁻¹ of fuelwood (Grundy et al., 1993), it is not surprising that smallholder farmers seem reluctant to invest in eucalypt plantations for fuelwood (5.5*35=\$192.5). Similar calculations can be carried out for other

commodities for which reliable data exist, but would need to be carefully interpreted as the results clearly depend on the interest rate chosen.

The relationship between tree cover and the values derived for tree resources were as expected; total tree resource values were higher in areas with low tree cover (i.e. where the proportion of the area covered by trees was low) than in areas with high tree cover (Table 8). Values derived for fuelwood, household and farm materials, crop inputs, animal feed and ecological properties were significantly higher in areas with low tree cover. These results indicate the relative scarcities of tree resource commodities and how these are valued by households.

The commodities that are more highly valued in areas of low tree cover are those towards which research efforts should be directed. The magnitude of the differences in value between areas with high and low tree cover are indicative of the costs of changing from a high to a low state of access to the particular commodity. For example, to increase the availability of tree resources from a low to a high state would yield added benefits to the average household of about Z\$228 for materials, Z\$173 for fuel, Z\$122 for crop inputs, Z\$110 for ecological properties and Z\$91 for animal feed (Table 8). These added benefits provide clear indicators of where agro-forestry research should be focused. It remains for researchers to develop technologies that will provide these returns at costs lower than their current value to the householder.

Table 8. Mean values (Z\$), 95% confidence intervals, rank (by value) and difference in value (Diff) for categories of tree commodities in areas with low and high tree cover.

	Value in areas with low tree cover (Z\$)	Rank	Value in areas with high tree cover (Z\$)	Rank	Diff. (Z\$)
Fuel	471 350-633	1	298* 219-404	1	173
Materials	427 316-577	2	199** 141-279	2	228
Crop inputs	292 209-406	3	170* 120-242	3	122
Ecology	239 169-337	4	129* 89-187	5	110
Animal feed	233 163-333	5	142* 100-200	4	91
TOTAL	1452		938*		724

*, ** Values between areas with low and high tree cover significantly different (* $p < .05$; ** $p < .001$).

Societal values

The professionals' survey was administered to a small sample ($n=39$) although the total population was also likely to be small, probably numbering only a few hundred.

Overall, the professionals assigned a higher total value to the goods and services that households derived from trees than did the CA residents themselves. The sum, across all categories of tree derived goods and services, of the median anchor-standardized scores assigned by professionals, was almost double the sum of CA resident median scores (Table 9). The allocation of value to each category differed between professionals and CA residents for several categories of tree-derived goods and services. Professionals perceived building materials and inputs to crop production to be of lower relative value than did CA residents (Table 10). Professionals also placed a generally

higher value on food, cash income and societal services categories than did CA residents (Table 10).

Table 9. Median anchor-standardized scores for tree commodity categories by Natural Regions as allocated by professionals and by household respondents.

Natural Region	Professional II & III	Professional IV & V ¹	Mangwende residents II	Shurugwi residents III	Chivi residents V
Fuelwood	1.11	0.80	0.55	0.46	0.50
Farm / house materials	0.88	0.65	0.50	0.40	0.50
Ecological services	0.71	0.50	0.33	0.20	0.33
Food	0.83	0.63	0.27	0.18	0.25
Cash	0.67	0.44	0.33	0.10	0.13
Crop production	0.67	0.34	0.37	0.30	0.41
Social services	0.43	0.24	0.11	0.06	0.10
Animal feed	0.36	0.50	0.37	0.20	0.28
Health	0.50	0.32	0.22	0.13	0.14
Shade	0.40	0.33	0.21	0.13	0.16
TOTAL	6.56	4.75	3.26	2.16	2.80
N	29	30	108	117	122

1. Points were standardized against the points given to the borehole - scores are therefore in units of "boreholes". Source: Professional survey and household survey.

Table 10. Percentage of summed medians of anchor-standardized scores allocated to tree commodity categories by professionals and by household respondents.

Good / service	Professional II & III	Professional IV & V ¹	Mangwende residents II	Shurugwi residents III	Chivi residents V
Fuelwood	17	17	17	21	18
Farm / house materials	13	14	15	19	18
Ecological services	11	11	10	9	12
Food	13	13	8	8	9
Cash	10	9	10	5	5
Crop production	10	7	11	14	15
Social services	7	5	3	3	4
Animal feed	5	11	11	9	10
Health	8	6	7	6	5
Shade	6	7	6	6	6
TOTAL ²	100	100	98	100	102
N	29	30	108	117	122

1. Points were standardized against the points given to the borehole - scores are therefore in units of "boreholes". Source: Professional survey and household survey.

2. Due to rounding percentages may not add to 100.

These results illustrate the somewhat different perceptions of value held by smallholder farmers, who capture most of the direct benefits and costs of tree resources, and professionals selected to represent informed members of society. In the development context, the values of those who will directly bear the costs and derive the benefits of resource use are held to be paramount (Chambers, 1983). Some of the differences in assigned value are likely to be attributable to ignorance on the part of the professionals. There seems to be a lack of understanding by professionals of the importance of trees to crop production in the CAs. Other differences are likely to be due to differences in what

individuals and professionals see as being best for society. Professionals need to address the first cause of differences so that they are better placed to make informed and unbiased decisions regarding the true value of trees to society.

Implications for policy and research

The results of this study provide clear indicators to assist in establishing research priorities for Zimbabwean indigenous woodlands.

- 1) The high value assigned to the consumptive category of farm and household materials had important implications for the sustainable use of CA woodlands. As a top priority researchers need to develop reliable estimates of the growth rates, reproductive performance and responses to management practices of indigenous woodlands. Only when these are known can reliable estimates of sustainable harvest or use rates be made. This knowledge will also assist in establishing the amounts of woodland required to provide given levels of non-consumptive or of rival goods such as soil protection.
- 2) The values placed on tree resources by smallholder farmers are likely to differ quite substantially from those held by researchers and administrators. Failure to correctly identify the values and objectives of target agents could result in the development of inappropriate technologies and attempts to apply inappropriate policies. To reduce the likelihood of this occurring researchers need to, a) identify the values and objectives of CA residents and how these change as the availability of tree-derived goods and services change and, b) identify conflicts between the interests or values of CA residents and society taken as a whole.

- 3) Few of the categories of goods and services valued in the current study were exchanged in trade of any kind. The only costs households incurred in using or having the option to use these goods or services were the opportunity cost of their labour time and the opportunity cost, to their own household, of the good or service. This latter cost would be negligible except where the good or service was scarce. The potential for overuse of resources under these conditions has long been recognized (Dasgupta, 1982). Allocative institutions other than markets are therefore needed to ensure efficient use of tree resources under the common property tenure regimes existing in the CAs. Research is urgently required to improve our understanding of the institutional controls governing access to, and the use of, tree resources and of identifying culturally appropriate institutions for the efficient allocation of tree resources under conditions of scarcity. Allocative mechanisms in the absence of secure property rights are, however, unlikely to be effective or sustainable.
- 4) The major foci of research for improving the tree resource base of CA farmers should include the development of technologies that provide a) farm and household materials, b) fuelwood, c) inputs to crop production, d) ecological stabilization and e) animal feed. Improved management of the indigenous woodlands may provide the best option for the low cost and sustainable provision of these goods and services. Planting of exotic species, such as *Eucalyptus spp.*, to provide needed goods and services does not appear to be cost effective for CA farmers (Bradley and Dewees, 1993). Our technical understanding of, and hence ability to effectively manage, indigenous woodlands is, however, very weak (Scoones and Matose, 1993) and requires urgent research attention.

SUMMARY

1. An anchored scoring and contingent valuation method was used to determine the value of tree resources to smallholder farmers in three CAs of Zimbabwe.
2. Tests of the validity of the results were conducted and indicated that the survey results were valid reflections of the values assigned by smallholder farmers to the tree resources to which they had access.
3. Farmers valued direct inputs to the household (fuel and materials) most, then inputs to other production activities (crop and animal production), then ecological services, food and shade and lastly cash income, health and social services.
4. The value of tree resources could be equivalent to between 47 and 59 percent of the annual household incomes derived from agricultural activities.
5. The values of farmers obtained in the survey reflect the relative scarcity of tree resources with values of tree resources being higher in areas with low tree cover than in areas with high tree cover.
6. The added benefits derived from moving from a low tree cover to a high tree cover situation, in terms of improved access to resources, was about Z\$228 for materials, Z\$173 for fuel, Z\$122 for crop inputs, Z\$110 for ecological services and Z\$91 for animal feed.
7. Professionals assigned a higher total value to tree-derived goods and services than did CA residents. Professionals and CA residents also assigned different relative values to building and household materials, to crop inputs, to food, to cash

income and to societal services. These differences were believed to have important policy implications.

CONCLUSIONS

Communal Area tree resources make significant contributions to household incomes and hence well being. The high value placed on the goods and services households derive from trees and the relatively low costs, to CA households, suggest these resources may be over-used. There can be little doubt that CA households recognize the ecological value of trees; the rapid decline in woodland areas in Zimbabwe's CAs is not, therefore, a result of the ignorance of CA residents. In the absence of markets, non-market mechanisms that efficiently allocate these tree resources are required as a matter of great urgency.

Currently available technology is unable to deliver the wide array of goods and services CA households derive from their indigenous trees at costs lower than what CA residents currently pay. Research is urgently needed to improve our understanding, and hence ability to manage indigenous woodlands. Improvements in the management of CA woodlands are, however, likely to be effective only under clearly defined property rights regimes.

The approach developed in this study of using an *anchor* whose monetary value was derived using a contingent valuation method, yields reliable and useful estimates of the value of goods and services households derive from woodlands under a common property rights regime.

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Appendix 1: Household questionnaire.

VALUE OF TREES TO COMMUNAL FARMERS - HOUSEHOLD QUESTIONNAIRE

NAME OF RESPONDENT _____ AREA _____

QUESTIONNAIRE NUMBER _____ ENUMERATOR NUMBER _____ DATE _____

SECTION ONE

Enumerator instructions: Ask the questions and put 1 for yes or 2 for no in the appropriate box.

1. Does your household use any of the following foods from the bush?
 - wild fruits.....
 - wild vegetables.....
 - mushrooms.....
 - insects.....
 - honey.....
2. Does your household use wild foods in main meals?.....
3. Does your household make greater use of wild foods in drought years?.....
4. Does your household use materials from trees for any of the following?
 - rope and cord.....
 - agricultural implements.....
 - utensils for home use.....
 - brush fencing.....
 - building of homes and granaries.....
5. In the past year, has any member of your household earned cash from selling any of the following?
 - fuelwood.....
 - timber.....
 - wild fruits.....
 - fruits from planted trees.....
 - crafts made from trees.....
 - rope from trees.....
 - medicines from trees.....
 - gum.....
 - mushrooms.....
 - insects.....
 - honey.....
6. Does having some types of trees scattered in your fields improve your crop yields?.....
7. Does your household bring tree litter to the field to improve the soil fertility?.....

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8. Does having trees make it possible to have a greater number of cattle?..... ☐
9. If there are a lot of trees in your district will this increase the rainfall?..... ☐
10. Do trees reduce soil erosion?..... ☐
11. Do trees reduce the amount of rainfall available to crops?... ☐
12. In the past five years, have members of your household planted trees for any of the following?
- | | |
|-------------|--------------------------|
| shade..... | <input type="checkbox"/> |
| timber..... | <input type="checkbox"/> |
| fuel..... | <input type="checkbox"/> |
| fruit..... | <input type="checkbox"/> |
| fences..... | <input type="checkbox"/> |
13. Is it important to you to have trees around your house or in the bush for your children to play in?..... ☐
14. Are trees important to the spiritual well-being of your household?..... ☐
15. Do you use trees to mark the boundaries of your fields?..... ☐
16. Would you prefer to have a few trees of many varieties rather than many trees of few varieties?..... ☐
17. Do women depend on tree resources more than men?..... ☐
18. Do rich people depend more on tree resources than poor people?..... ☐
19. Is management of tree resources improved when you own the trees (rather than them being found in the grazing area)?.... ☐
20. Do you think that your available tree resources are adequate for your needs?..... ☐

If no, what could be done to improve your tree resources?

- a) _____
- b) _____
- c) _____

SECTION TWO

Find out how important trees are to the respondent in each of their roles:-

ITEMS	RANKING	POINTS
1. FRESH DRINKING WATER (hand boreholes)	_____	_____
2. [†] FOOD (trees providing fruits, insects, honey, mushrooms)	_____	_____
3. [†] FUEL (firewood for cooking, bread making, beer brewing)	_____	_____
4. [†] BUILDING MATERIALS (from trees for houses, fences, furniture, implements, crafts, rope, sculpture)	_____	_____
5. [†] HEALTH (traditional medicines from trees)	_____	_____
6. CASH INCOME (sale of tree products: food, fuel, building materials; medicines, crafts)	_____	_____
7. IMPROVED CROP PRODUCTION (tree litter, maintaining soil fertility)	_____	_____
8. ANIMAL FEED (browse)	_____	_____
9. SHADE (trees shading animals, people or houses)	_____	_____
10. ECOLOGICAL PROPERTIES (trees controlling the movement of soil, water and nutrients, cleaning the air etc)	_____	_____
11. SOCIAL ASPECTS (the cultural, spiritual and recreational roles of trees)	_____	_____
12. BLAIR TOILET	_____	_____

[†] Home use specifically

TOTAL 50

Notes to enumerator:-

- Please check that the points add up to 50.
- Please be sure to explain all the categories thoroughly to the respondent. Each respondent is seeing the cards for the first time.

SECTION THREE

PART ONE

Enumerator instructions: Tell the respondent that you want them to imagine the following situation and READ the following to them:-

"You have got together with four other households to sink a borehole. You can be certain of finding water and of maintaining exclusive use for your households. You will be able to get a loan from the bank at no interest but must pay it back within 5 years. The money from each household will be deducted directly by the GMB or CMB after you deliver your harvests each year."

If the respondent says he/she cannot afford to pay anything but would like a borehole, tell them that they can pay in days of labour at the minimum wage.

How much would he/she be prepared to pay for his/her share of the borehole if he/she were one of five families investing?.....

\$

PART TWO

Now read to the respondent the following situation:-

"The government has decided to carry out some construction which means that the borehole your household uses will have to be destroyed. The government has agreed to pay cash compensation to each of the five households that use the borehole."

How much compensation would he/she be willing to accept for the loss of his/her share of the borehole?.....

\$

PART THREE

Now ask the question "Would you rather have a borehole shared with four other households or.....?"

1. Shared borehole 1 Tractor 2.....
2. Shared borehole 1 Grinding mill 2.....
3. Shared borehole 1 One bull & two heifers 2.....
4. Shared borehole 1 Scotch cart 2.....
5. Shared borehole 1 Cultivator 2.....

SECTION FOUR

Sex of respondent.....1 Male 2 Female.....

Age of respondent in years.....

Years of education received by respondent.....

Years respondent resident in area.....

Number of people in household.....

Main crops grown by household.....

1 Maize 2 Cotton 3 Rapoka 4 Sorghum 5 Bulrush Mhunga
6 Tobacco 7 Groundnuts 8 Vegetables 9 Other (specify)

Number of cattle owned by household.....

Number of goats owned by household.....

Do you have access to a hand borehole?....1 Yes 2 No.....

If yes, how many families use it?.....

Where does your household get most of its drinking water?....

1 River 2 Well 3 Borehole 4 Dam 5 Other (specify)

Do you own a... 1 Yes 2 No

Pickup truck.....

Scotch cart.....

Plough.....

Bicycle.....

Radio.....

Wheelbarrow.....

House type.....

1 Brick with corrugated iron or asbestos roof and framed
glassed windows

2 Brick with corrugated iron or asbestos roof without framed
glassed windows

3 Brick with thatched roof and framed glassed windows

4 Brick with thatched roof without framed glassed windows

5 Wattle and daub with thatched roof

Enumerator signature_____ Number_____

Date_____

Supervisor signature_____

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Appendix 2. Descriptions of categories of tree goods and services and dichotomous choice variables.

Table A2.1. Descriptions of the categories of tree based goods and services used in the survey.

CATEGORY	DESCRIPTION
Food	The provision specifically for home use of fruits, insects, honey and mushrooms.
Fuel	The provision specifically for home use of firewood for cooking, bread making and beer brewing.
Building materials	The provision specifically for home use of materials such as poles and fibre for houses, fences, furniture, implements, crafts, rope and sculpture.
Health	The provision specifically for home use of traditional medicines.
Cash income	The provision specifically for sale of tree products such as food, fuelwood, building materials, medicines and crafts.
Improved crop production	The provision of tree litter and the maintenance of soil fertility.
Animal feed	Browse.
Shade	The provision of shade for animals and for people.
Ecological properties	The role trees play in controlling the movement of soil, water and nutrients as well as in cleaning the air.
Social aspects	The cultural, recreational and spiritual roles of trees.

Table A2.2. Items used in dichotomous choice questions with the mean value taken from a survey of suppliers. Sample size shown in parentheses.

ITEM	ESTIMATED VALUE (ZS)
Tractor	22800 (15)
Grinding mill	12000 (21)
One bull and two heifers	1200 (31)
Scotch cart	735 (30)
Cultivator	280 (31)