Peace, health or fortune? – Preferences for chicken traits in rural Benin

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This paper has been published in Ecological Economics and should be cited as:

Vidogbèna, F., Adégbidi, A.A., Garnett, S.T., Koudandé, D.O., Agbo, V. and Zander, K.K. 2010. Peace, health or fortune?: Preferences for chicken traits in rural Benin. *Ecological Economics* 69: 1849-1858.

http://www.sciencedirect.com/science/article/pii/S0921800910001862

Abstract

Fifty-four percent of Benin's population in rural areas keep indigenous chickens for subsistence livelihoods. Maintaining diversity in chicken gene pools can provide several benefits for farmers, including risk pooling, diversification of income and maintaining availability of chickens suitable for cultural ceremonies. Despite the potential to alleviate poverty by improving indigenous chicken breeds, smallholders' participation in the implementation of breeding programmes is weak. Participation can be improved with greater understanding of the many functions of chickens to smallholders, particularly their economic contribution. The objectives of this study are (1) to evaluate chicken traits including market and non-market values, and (2) to assess factors that influence the conservation of indigenous breeds. Choice modelling, a multi-attribute preference elicitation technique, was applied across 300 households in two districts in Benin (Dassa and Toffo). The results revealed that adaptive and performance traits in chicken breeds are highly valued by farmers and that preferences differed greatly between farmers in the two districts. Many of the preferred traits are expressed in indigenous chickens, whose conservation should be supported through village chicken breeding programmes. However, a preference for white plumage, most common among exotic breeds, could hinder conservation of indigenous breeds, which are mostly brown or black. From an economic point of view, the aim of conserving culturally significant and disease resistant indigenous breeds is contrary to the objective of increasing chicken productivity. The lack of knowledge about chicken characterization and a lack of flock management were identified as further severe constraints to village breeding and conservation programmes.

Key words: Animal genetic resources; Backyard poultry; Choice modelling; Cultural value; Indigenous breeds; West Africa

1. Introduction

Poultry are the most common form of livestock in the rural areas of Benin, which support 70% of the population (Adégbidi, 1999; Blench et al., 2003). The total number of poultry is estimated to be 29m head. Of these 90% (26m) are kept in traditional systems (extensive and multi-purpose use) (Blench et al., 2003). Among poultry, chickens are the most frequently kept species (80-90 %) (Chrysostome et al., 2001; FAO, 2001). Chickens account for 21% of national meat production, behind beef (58%) but more than meat from sheep and goats (13%) or from pigs (7%) (DE[1], 2005 cited by Onigbon and Sodégla, 2005). Chicken meat production contributes 2.4% of agricultural profit in Benin, with egg production contributing 1.4% (Onigbon and Sodégla, 2005). About half the poultry are of indigenous breeds reared in traditional, mostly resource-poor, production systems (Onigbon and Sodégla, 2005).

1.1. Conservation of chicken genetic resources

The proportion of chicken breeds considered endangered is higher in developed than developing countries, because those breeds not already extinct are severely threatened and chicken production is based almost entirely on hybrids. However the absolute number of endangered chicken breeds in developing countries is higher than in the countries of Europe and North America (Table 1). This impression is probably distorted because reliable population data that allows risk classifications is lacking for many indigenous breeds in developing countries (FAO, 2000; 2007). Indigenous chickens are those kept in extensive small scale systems, scavenging free-range, having no identified description, and being multi-purpose and unimproved (Horst, 1989). These indigenous chicken breeds are particularly important for livelihoods in developing countries, where they are ubiquitous among rural households and contribute significantly to food security.

[Table 1 here]

[1] DE: Direction technique du Ministère de l’Agriculture, de l’Elevage et de la Pêche, chargée de l’élevage

Despite operating in a low-input / low-output system, products from backyard poultry are diverse and their total economic value (TEV) exceeds conventional measures of productivity and other market-values. The conservation of chicken genetic resources secures chicken breeds can thus have both market and non-market functions for farmers. The greatest value of indigenous chicken populations is as a gene reservoir, particularly those genes that have adaptive value for local conditions. The future improvement and sustainability of indigenous chicken production systems is dependent upon the availability of this genetic variation (Benítez, 2002), both within and between breeds (Abdelqader et al., 2008). Resource-poor farmers have limited resources to allocate to different farming activities, and in most cases chickens are left to scavenge for feed and drink unclean water. This exposes them to disease and predators which farmers cannot afford to treat or prevent. Indigenous breeds are selected to survive this harsh environment.

The depletion and extinction of the genes which enable persistence in this environment could thus have devastating consequences for household economics. Because backyard rearing of poultry is resource-extensive, indigenous chickens, unlike intensively raised chickens, live and produce in a broad spectrum of socio-economic and physical production environments (Gondwe and Wollny, 2007). The income from the sale of eggs, meat and the indigenous chickens themselves is important to finance daily purchases and to generate cash. Many households cannot afford to keep intensively-raised chickens because they usually require more input (supplementary feed, health care) which resource-poor farmers cannot afford. For such households indigenous backyard chickens meet multiple social, economic and cultural needs (Muchadeyi et al., 2007). Furthermore, unlike other livestock species, particularly cattle, chickens can be kept even by those without land (Muchadeyi et al., 2007).

However, indigenous chicken genetic resources in many developing countries (e.g. in the Amhara region of north-west Ethiopia [Halima et al., 2007] and in Zimbabwe [Muchadeyi et al., 2005; 2007]), are seriously threatened. This is not only because of the high rate of mortality resulting from Newcastle disease and predation (Halima et al., 2007) but also because the extensive unplanned distribution of exotic chicken breeds by both government and non-government organizations has resulted in dilution of the indigenous genetic stock. If this trend continues, the gene pool of the indigenous chickens could be lost in the near future. The threats are being accelerated by population pressure and increasing demand for poultry products, driving some small scale farmers to introduce exotic/improved germplasm (Kumaresan et al., 2008). While this may enhance profitability for those farmers in the short-term, there are many reasons why complete loss of the indigenous genetic poultry resources would be detrimental to the wider population.

1.2. Objectives

The dominant chicken production system in Benin is low input/low output backyard production (Houndonougbo, 2005). We hypothesise that a successful strategy for backyard chicken production under village conditions in Benin cannot be developed without indigenous chickens because the inputs for exotic chicken production cannot be afforded by many farmers. To improve farmers' livelihoods, many farmers seek to increase the productivity of indigenous chickens. However, to maintain a genetic pool for future use and to increase the chances of recovery from unforeseen natural disasters and epidemics, higher productivity should be pursued alongside the conservation of chicken genetic resources. This requires that farmers trade-off values when choosing their chicken breeds or participate in village breeding programmes. From an economic point of view emphasis for conservation should be given to those chicken breeds that provide maximum utility to their keepers and have the highest genetic diversity (see e.g. Weitzman, 1998; Zander et al., 2009). A study on farmers' preferences for chicken traits and breeds is thus an essential precursor of any attempted intervention in the chicken breeding sector.

The aim of this paper is to (1) provide information about indigenous backyard chicken production in Benin, (2) assess preferences for chicken traits and, through this, the TEV of indigenous chicken breeds and (3) understand heterogeneity among households preferring certain traits that are expressed in indigenous and/or non-indigenous breeds.

2. Materials and methods

2.1. Study area

The research area comprised four villages in two districts, Dassa in Central Benin and Toffo in southern Benin (Figure 1). The two research districts were chosen because they are part of the large GTZ-BMZ funded project: "Improving the Livelihoods of Poor Livestock-keepers in Africa through Community-Based Management of Indigenous Farm Animal Genetic Resources" which also includes parts of Kenya and Ethiopia.

[Figure 1 here]

The main ethnic groups are Datcha and Mahi with some Fulbe (Peulh). The Mahi have taken on the role of keepers, breeders and distributors of chicken reproductive material obtained from a cross-breeding project, "opération coq", implemented in the 1960s. As a result of this project a new breed, "Fulani", is often used in place of indigenous chicken breeds, particularly in the Dassa district. Toffo, being close to Cotonou, where most new chicken genetic material is imported, is influenced by many different breeds. Table 2 provides an overview of the districts' characteristics.

[Table 2 here]

2.2. Data collection and sampling

Data were obtained using a semi-structured questionnaire. In-depth interviews were held in October/November 2006 upon which the design for the choice experiment (CE) was based, i.e. the selection of traits. A pilot study was conducted in December 2006 to test this CE in focus group discussions and individual interviews with elders. After some modifications (the levels for the attribute “disease resistance” were increased from two to three), the main survey with the final questionnaires and CE was undertaken in February and March 2008 after a second testing phase of six days in January 2008. In total, 300 households were randomly selected; 147 in Dassa and 153 in Toffo. Two villages in each district were sampled with an equal number of interviews conducted in each. The four villages were as follows (number of respondents in brackets): Gnonkpingnon (120) and Dewe (24) in Dassa district; Houngo govè (87) and Zèko bopa (66) in Toffo district. The largest number of respondents was interviewed in the village Gnonkpingnon because of the size of the chicken production.

2.3. Applied methods and analyses

Economic Framework

Choice modelling is based on consumer demand theory (Lancaster, 1966; Rosen, 1974), stipulating that consumers not only derive utility from a good *per s*e but from the complex of different characteristics embodied in the good. With regard to our study this means that farmers in Benin are assumed to derive utility from separate chicken traits, including all direct and indirect benefits a certain trait might produce, i.e. the chickens’ total economic values (TEV). The concept of TEV is pivotal in the field of environmental evaluation. The TEV is comprised of the use value (UV), the non-use value (NUV) and the option value (OV). The UV includes the direct or indirect values derived from the consumption or sale of products. For chickens this can include meat and eggs, organic fertiliser and feathers for use in ceremonies. The direct values can be assessed by observing market transactions. The indirect UV are the ecosystem and cultural values. The types of NUV can be manifold but are conveniently classified into existence, altruistic and bequest values (Bateman et al., 2003; Pearce and Moran, 1994). The NUV are intangible values, not traded at the markets (like many indirect use values), and include, for chickens, simply enjoying the existence of a particular breed and by knowing that it will still be there for future generations. The OV captures the values that the genetic pool will have in future for maintaining global biodiversity and for coping with unforseen future catastrophes (epidemics, natural disasters) where characteristics of a breed guarantee chicken production for future generations. If chickens in the research area are sold on markets, their purchase prices are often underestimated because of the many NUV and OV a particular chicken breed can provide to a buyer. Applying a CE can alleviate this problem by asking respondents to make trade-offs between a variety of chicken traits which are both of UV and NUV, and hence a more realistic economic value of chickens can be found.

The economic theory of environmental evaluation is based on individuals' willingness-to-pay (WTP) for the benefit gained from an additional quantity or quality of chickens with particular traits or the willingness-to-accept (WTA) compensation to bear the loss from a decrease in quantity or quality of a trait in chickens. The WTP/WTA estimates reflect farmers' preferences and their welfare changes. The sum of all WTP and WTA values for the relevant traits defines the TEV of chickens with these traits. Determining TEV through an individual's WTP and the application of CE has been successfully applied with regard to many environmental goods, including animal genetic resources (AnGR). In East Africa, choice models have been applied to assess cattle (Scarpa et al., 2003; Ouma et al., 2007; Ruto et al., 2008; Zander and Drucker, 2008), sheep (Omondi et al., 2008a) and goats (Omondi et al., 2008b).

Choice experiment specifics

In a CE, respondents are presented with sets of alternative combinations of attributes (here chicken traits), and asked to make trade-offs by choosing their most preferred alternative combination. Respondents make their choices based on the utility they derive from the characteristics of the alternatives as well as on some degree of randomness (Scarpa and Willis, 2009). This is known as random utility framework theory.

The utility (U) a respondent i receives from a certain combination of chicken traits given by an alternative j (from K alternatives) in a choice situation is:

$$\mathrm{U}_{ij} = \mathrm{V}_{ij} + \varepsilon_{ij} \text{ , } j = 1,...,\mathrm{K} \qquad (1)$$

V_{ji} is the non-stochastic utility function and ε_{ji} the error term. V_{ji} is assumed to be linear with $\mathrm{V}_{ij} = \beta_i ' x_{ij}$. In a basic multinomial logit model (MNL), the error term is assumed to be independent and identically distributed (IID) following a standard extreme value type I distribution across individuals (Train, 2003; Hensher et al., 2005a). This conveniently allows use of a closed-form expression for the probability *P* of an individual i choosing alternative j from a choice set C as (McFadden, 1974):

$$P_{i(j)} = exp\,(\beta' x_{ij}) / \sum_k exp(ß' x_{ik}) \quad j,k \in C \qquad (2)$$

This MNL model relies on the restrictive assumption of independently and identically distributed (IID) error terms across alternatives and observations and hence, presumes homogeneity of preferences, which might not be well suited to the realistic taste preferences of individuals. Recent research on stated choice data has aimed to develop models that relax this strong assumption and adopt different distributions for the error term, and different structures in decision-making (Scarpa and Willis, 2009). The latent class (LC) model, the nested logit (NL) model and the mixed logit (MXL) model, also referred to as random parameter logit (RPL) model, are three commonly used models that relax the IID assumption. In the NL model, however, the IID property is retained within nests but not between nests. The MXL model is now applied widely, outperforming the basic MNL model. Most recent choice models have explored the use of Error Component (EC) models which give additional flexibility in the covariance structure of choice models (Scarpa et al., 2008; Hu et al., 2009).

We applied a panel MXL model to account for unobserved preference heterogeneity across respondents, i.e. allowing taste parameters to vary randomly across respondents according to the parametric distribution. Train (1998), McFadden and Train (2000), Hensher and Greene (2003) and Train (2003) are pioneers in applying MXL models for detecting unobserved preference heterogeneity and details on the MXL model specifics can be found in their papers. MXL models do not have a closed form like MNL models but the probabilities are obtained from integrals of the standard logit probabilities over all possible values of β following an underlying distribution (Hensher and Greene, 2003). This distribution can be, for instance, normal, lognormal, or triangular (Hensher and Greene, 2003). The integral is approximated through simulation, using a specified number of draws.

Welfare estimates in MXL models

Welfare estimates, expressed as WTP/WTA are derived from MNL models by calculating the ratio $-\beta_j / \beta_{price}$, where β_j is the coefficient for the chicken attribute and β_{price} is a monetary attribute, which is associated with the costs of obtaining the chicken with the attribute in question. The calculated welfare estimate represents the marginal rate of substitution between prices and traits, *ceterus paribus* (c.p.). If the calculated ratio is negative, it signifies that switching to a certain chicken trait constitutes a cost rather than a benefit. In such cases, the welfare measure becomes a WTA compensation for keeping chickens with detrimental traits.

Calculating welfare estimates from MNL models, implies that the distribution of marginal WTP values in the population are jointly determined (Scarpa and Willis, 2009). When applying a panel MXL model, which we do in this paper, this implication would be false but instead the welfare estimates must also be approximated via simulations (Hensher et al., 2005a; Thiene and Scarpa, 2009.). Two alternatives have been proposed for the problem of assuming that, in deriving welfare estimates from MXL models, the conventional point estimation of WTP/WTA the parameters were assumed to be non-random when in fact they were random. Hensher et al. (2005a) proposed that the expected welfare estimates be obtained using unconditional parameter estimates through simulations (Hensher et al., 2005a, p.688; incorporated into Limped Nlogit (version 4.0)). Alternatively, Thiene and Scarpa (2009) suggest an approach, applied here, in which a large number of variates are drawn from both the fixed price parameter (α) and the random parameter for the relevant chicken trait (β) then combined into pairs in order to compute the values of $WTP/WTA^r = \alpha^r / \beta^r$ for each replicate r.

2.4. Design of choice experiment

Traits for the choice experiment

The decision regarding which traits to include in the CE was systematic involving literature reviews and an in-depth pilot study with focus-group discussions in which participants determined the most important traits of chickens. In this pilot study, eleven attributes were highlighted as desirable: good disease resistance, high laying rate (≥ 10 eggs per cycle), good hatching rate (preferably ≥80%), high rate of survival at independence (preferably ≥60%), high hatching frequency = short interval between breeding cycles (preferably ≥3 cycles *per annum*), precocity in laying, good mothering ability, docility, body weight, colour of plumage, and market price. The attributes and their levels are presented in Table 3.

[Table 3 here]

Disease resistance: Given the degree of poverty and the lack of available veterinary services or medicines, disease resistance is one of the most important livestock traits. Health and disease resistance constitute indirect use-values, indirectly influencing productivity of chickens. In the CE, we accounted for disease resistance by including three levels: 1) the chicken becomes ill and dies (“ill and die”), 2) it becomes ill but survives the disease (“ill and survive”) or 3) it rarely becomes ill (“not ill”). We assume that a chicken breed has the highest disease resistance if the animals fall ill but survive and so develop some degree of immunity.

Hatching frequency: The hatching frequency determines productivity and income generation and hence is a trait with pure use-value. It largely depends on the hen’s behaviour. A good mothering hen in traditional breeding systems broods and hatches chickens at least three times a year. Frequency is lower among crossbred chickens than among indigenous chickens, while exotic breeds usually hatch chickens twice a year. This trait has two levels in the CE: 1) “Twice a year” or 2) “Three times per year”.

Body weight: Body weight also provides a classical use-value. This trait distinguishes indigenous breeds from cross-breeds and exotic breeds. The levels of body weight used in the CE signify weight at an adult age of six months, when they are ready to sell. When kept under the same conditions, exotic breeds are the heaviest at this age with the highest fodder consumption, followed by cross-breeds. Indigenous breeds show the lowest body weight gain because no programmes for improved selection have so far been implemented for indigenous breeds. In indigenous chickens, hens’ bodyweight varies from 1.5 to 1.8 kg, with exotic/commercial chickens averaging 2.5 kg. With their low weight they are very adaptive and can survive in rural villages with harsh environments without any particular care (e.g. free-range and without any dedicated supply of feed and water). Because of their low weight and rather poor fodder utilization, indigenous breeds require less feeding and can cope with second-rate products, which is the main reason for rural households to keep them in the backyard. Because they forage for themselves, indigenous chicken need less purchased feed for each unit of weight gain than exotic breeds. In the CE, this trait can have three levels: 1) 650 g, 2) 900 g or 3) 1150 g.

Colour of plumage: This trait has socio-cultural significance. White feathers are considered a symbol of peace so white was expected to be the most preferred plumage colour. Other colours are liked less because they are thought to cause misfortune (e.g. black feathers in some districts). However, white plumage is not relevant for ceremony for which the preferred colour depends on the ceremony type. Black chickens are, for instance, used in magic while a reddish plumage is important when offered as a gift to a relative's spirit. Chickens with brown plumage are commonly used for human consumption. Indigenous chickens can be white, brown, black or red, or any combination of these four. Exotic breeds and commercially produced broilers have monochrome plumages (mostly white or black) with their colours depending on the source of the animals. Other exotic breeds also tend to have a single colour but mixtures appear when exotic breeds are crossed with indigenous chickens. The CE includes three possible plumage colours: 1) black, 2) brown (which includes reddish) or 3) white.

Market price: Prices are thought to depend on two main factors, body size and health, based mainly on external appearance at the time of purchase. Thus indigenous breeds are cheaper than cross-breeds which are less expensive than exotic breeds. We include three levels of this trait in the CE: 1) 1050, 2) 1450 or 3) 2000 CFA per adult animal.

The creation of choice sets

Experimental design lies at the core of all stated choice studies (Scarpa and Rose, 2008).The aim of experimental design is to create an efficient design which maximises the information in the experiment and at the same time leads to accurate utility coefficients at a manageable sample size (Vermeulen et al., 2008). We applied a D-efficiency criterion which aims at constructing a design that minimises the point D-error (see Scarpa and Rose [2008] for the statistics). There are 162 (3^4*2^1) ways to combine the five selected traits (often called attributes in a CE setting) (see Table 3) and their levels. Each combination of the five traits and their levels is called a profile. Using all of the possible profiles is cognitively too challenging for respondents to score meaningfully. We therefore created 36 profiles out of the 162 possible by applying the SAS procedure of Kuhfeld (2003). Three out of the 36 profiles were then combined together into a choice set using the D-efficiency criterion. This resulted into a balanced design with 12 different choice sets (see Figure 2 for an example). Besides the three profiles, respondents were able to opt-out, i.e. decide they would not purchase any of the presented chickens in the choice set if given the opportunity. This fourth alternative was included because some respondents might not approve of any of the presented chicken profiles and "forcing" them to choose one of the alternatives presented would be inconsistent with demand theory (Bennett and Blamey, 2001; Bateman et al., 2003). The CE was designed as an unlabeled experiment (i.e. no breed names etc. were used for alternatives in the choice sets).

Respondents were presented with six of these 12 choice sets and were asked to choose one out of the three given chicken profiles or none (opt-out) in each of them. Every second respondent was presented with either choice set 1 to 6 or 7 to 12. The order of the presented sets was also alternated. Some respondents were presented with sets in the order of 1 to 6 or 7 to 12 and some in the order of 6 to 1 and 12 to 7, respectively.

[Figure 2 here]

3. Results

Three of the 300 interviewed farmers did not complete the choice experiment and were eliminated from the final data set, resulting in 297 valid responses.

3.1. Household and chicken production characteristics

Table 4 describes the demographics and basic production statistics of the two research districts. Most chicken keepers are women and children (Kitalyi, 1998). The ratio of female to male respondents was almost equal in this study because some women, although having principal responsibility for chickens, were reluctant to respond to the questionnaire and the CE because they were not the owners of the chickens. Instead we interviewed the male head of household. Almost half of the respondents were illiterate with a big discrepancy between the two districts.

[Table 4 here]

More chickens were kept per household in Toffo than in Dassa but the average income from chicken production per household was similar. Dassa seemed to be “richer” in terms of the total income from livestock and crop production. The high income from crop production (as compared to chicken production) was not surprising as about 80% of the respondents listed crop production as their main occupation. Few respondents kept many cattle or goats so income from this source was generally low.

Few respondents (9%) were able to name and describe the breed they were keeping. A large majority (91%) grouped many breeds together and only broadly distinguished between indigenous and non-indigenous breeds. Hence the dummy variable for breed was indigenous versus non-indigenous. The percentage of farmers keeping indigenous chickens was relatively low at 21% in Dassa and 32% in Toffo. In Dassa the average income from chicken production was slightly higher among farmers who kept indigenous chickens compared to those who kept exotic and crossbreeds while it was the other way round in Toffo, although the difference was not great.

In Benin the head of household usually controls resources such as land, capital and labour and hence almost all economic activities. This person would be the key person in the decision to introduce new technologies to conserve indigenous chicken breeds and the operation of conservation plans. The majority of respondents (71%) thought that decisions about management and breeding are up to the keeper of the animals and not controlled by the head of the household (i.e. can be introduced freely by any member of the household). Only 29% believed control of chicken breeding and the introduction of animals is the responsibility of the head of household, regardless of who looks after them.

More farmers in Dassa used chickens when conducting ceremonies than in Toffo. Respondents used about two animals per session, performing an average of about one ceremony per month.

3.2. Results of the choice experiment

The inclusion of an opt-out alternative, as done in this study, can modify the substitution pattern within the alternatives and thereby violate the assumption of IIA (Scarpa et al., 2008). We accounted for a structural bias by including an alternative specific constant (ASC) for the opt-out alternative in the utility function (see Scarpa et al., 2005). Scarpa et al. (2008) suggest that, since respondents who chose the status-quo or opt-out alternative have different preference structures to those who chose a chicken profile, simple inclusion of a constant cannot relax the violation of IIA. NL models are suitable for accounting for the opt-out/status-quo bias but they are unsuitable for detecting unobserved heterogeneity across respondents (the panel nature of CE data). Although Scarpa et al., (2005; 2008) applied EC models which were found to be efficient even when biased by the presence of opt-out or status-quo alternatives (Scarpa et al., 2005; 2008), we argue that the opt-out as we applied it here did not change farmers' preference patterns and that removing the opt-out would not affect their choices. No attributes were assigned to the opt-out alternatives and respondents only chose it when the other two alternatives they considered both unsatisfactory. Only 25 out of the 297 respondents (8%) chose to opt-out from choosing one of the three chicken profiles, and mostly it was for the same choice set. Only one respondent opted out twice while the remaining 24 individuals opted out only once out of the six presented choice sets. Eighty-eight percent of these 25 respondents opted out of the same choice set, providing strong evidence for a choice set in which both chicken profiles had extreme attribute levels, all of which appear to have been found unsatisfactory to respondents. Having the opt-out alternative prevented forced answers for this choice set.

The monetary attribute, the market price of the chicken, as well as the body weight, entered the models as continuous variables. All other attributes were treated as discrete variables. Therefore, for each attribute with L levels, we created L-1 discrete variables in order to avoid perfect dependence. The omitted level of each attribute was considered the base level. We assigned the following levels as base levels: for disease resistance = to not become ill easily, for hatching frequency = three times per year and for plumage colour = white. Estimates were obtained using 200 Halton draws to simulate the likelihoods. In all models, the price coefficient was fixed because this makes the calculation of welfare estimates convenient (Hensher et al., 2005b). For all random parameters we assumed normal distributions.

The ASC was negative and statistically significant within all models except that derived for Toffo (Table 6). This indicates a strong reluctance to opt-out. Results of two MXL models using the entire data set are presented in Table 5: Model 1 lacks interaction terms, Model 2 includes them and thereby accounts for the observed heterogeneity among respondents. Judging from the t-statistics the coefficients of all traits were significant in both models. The market price was negative, as expected, meaning that the higher the price of a chicken profile (alternative), the less likely that it was chosen. The trait "become ill and die" also had the negative signs as expected. The plumage colours black and brown showed negative coefficients as well, i.e. are not preferred by respondents, which was unexpected because this is a characteristic of indigenous chickens. The trait “become ill and survive” had the expected positive sign, as did “hatching twice a year”. This, however, was also unexpected because “hatching 3 times a year”, the base level, was assumed to yield higher productivity. In both models, the standard deviations were highly significant for all attributes but for “hatching twice a year”, which was then treated as fixed parameter. This signifies that no unobserved heterogeneity among respondents for this trait can be detected in our model. Greater magnitudes of the coefficients for the standard deviations than for the mean coefficients, indicating relatively large heterogeneity across respondents, were found for the traits “black plumage”, “brown plumage” and “body weight”.

[Table 5 here]

What determines preferences for chicken traits?

It is to be expected that different groups of people will have different utility from traits and therefore different WTP. While respondents’ unobserved heterogeneity can be detected by applying the MXL models, they are not well-suited for explaining the sources of heterogeneity (Boxall and Adamowicz, 1999). We tested the significance of socio-economic characteristics of respondents (see Table 4) on their preferences for chicken traits. Therefore, we interacted the relevant socio-economic parameters with each of the attributes (Model 2). A log-likelihood ratio test showed that including interaction terms led to an improvement in model fit[2]. The results of the final model (Model 2) are presented in Table 5 and only include those interaction terms which were significant.

The variables *Gender*, coded as dummy variable (1 = male, 0 = female), *Education* (coded 1 = illiterate, 0 = literate), *Occupation* and *Number of chickens* had no influence on respondents’ preferences for any of the chicken traits. *Income* was expected to have a positive

[2] The test statistic is -2(-847.76+742.87) = 209.78, which is larger than 11.07, the critical value of chi square distribution at 5 degrees of freedom and 0.5% significance (see Greene, 2003; p. 485 for the likelihood ratio test statistics).

effect on the preference for the market price of chicken, i.e. that respondents with a higher income would be prepared to pay more for chickens. However, the results showed that neither income from chicken production nor total income (all income from livestock and crop production plus that from handicrafts and small trading) significantly influenced the preference for market price or any other attribute. The fact that most of the characteristics describing respondents' household structures were insignificant signifies that all respondents were very homogenous in their socio-economic background. Significant interactions were found for the following three variables:

Use of chickens in ceremonies: Half of the respondents use chickens in traditional ceremonies with a higher share in Dassa and we expected that this factor could influence differences in respondents' preferences for at least the colour of chickens. The results, however, showed that ceremonial use only had a significant impact on respondents' trade-offs for chicken body weight. Respondents who use chickens in ceremonies prefer lighter chickens. This could be because heavy chickens are preferred as a source of food and that "inferior" chickens are sacrificed for ceremonial use.

Type of breed: Treated as a dummy variable (1 = indigenous breed, 0 = other breed), the type of breed had a significant positive influence on "market price" and on "brown plumage". This means that respondents who kept indigenous chicken breeds were more likely to choose the alternative in the CE with the higher price and with brown chickens.

District: District had a significant influence on two traits so was kept in the model as the dummy variable "Toffo" (0 = Dassa, 1 = Toffo). Respondents in Toffo were more likely to choose chicken breeds that were brown while respondents in Dassa were more likely to choose chickens that become ill but survive.

Preference heterogeneity among respondents in Toffo and Dassa

Given the preferences for so many attributes that seem to be influenced by the district, we tested whether or not the set of parameter estimates of the pooled model were shared across the two districts. Consequently, we ran separate MXL models for Toffo and Dassa to test the following hypothesis using the log-likelihood ratio test:

$$H_0 : \beta_{pool} = \beta_{Toffio} = \beta_{Dassa} \tag{4}$$

where β are the MXL parameter vectors. The null hypothesis that the regression parameters for the two models are equal was rejected under a log-likelihood ratio test because the test statistic is $\chi^2 = -2(-847.76 + 520.83 + 213.77) = 226.32$, which is larger than 22.36, the critical value of chi square distribution at 13 degrees of freedom and 0.5% significance. Therefore, the preferences for chicken traits were significantly different between the two districts. The results of both models are presented in Table 6.

[Table 6 here]

Both district-specific models yielded similar results with the same signs of coefficients and similar levels of significance for most attributes. In both models, the attribute "black plumage" was not significant and was omitted from the models. The major difference was that, for Dassa, the attribute "brown plumage" was insignificant. It was surprising that the colour did not seem to be of any significance to respondents in Dassa.

WTP estimates

The simulated welfare estimates were obtained following the approach outlined in Thiene and Scarpa (2009). A total of 10,000 replications were drawn from estimated distributions of both the price coefficient and the coefficient of the chicken attribute in question, and combined in pairs so that, for each replicate, r the values of $WTP^r = \alpha^r / \beta^r$ were computed. The welfare estimates derived from Model 1 and Model 2 are presented in Table 7 and, from the separate models for Dassa and Toffo, in Table 8. We report, the 25th, 50th (median) and 75th percentiles.

The welfare loss from chickens that are prone to illness and death was about €7 per chicken (Table 7). Chickens that hatch twice per year instead of three times per year provide a welfare gain of about €4 per chicken and for chickens that show disease resistance ("become ill and survive") between €7 (Model 1) and €15 (Model 2) per chicken. Respondents also lose utility when keeping black (<€1) and brown (between 1€ and €9) chickens instead of white chickens. The 25th and 75th percentiles reflect some unobserved preference variations in the population, which are especially noticeable for the trait "body weight" (from Model 1), suggesting that some respondents have a positive and some have negative welfare from heavy chickens. The same applies for "black plumage" when looking at the welfare estimates derived from Model 2. Some respondents gain from black chickens while some lose.

[Table 7 here]

[Table 8 here]

The magnitude of welfare loss/gain depends on the district. Table 8 indicates that the differences were large for "become ill and survive" (difference of €13 per chicken) and "twice a year hatching" (difference of €6 per chicken). A surprising discrepancy was found for "body weight". Respondents in Toffo valued chickens that have a high weight at the time they are purchased (at six months age) and were willing to pay almost €2 per extra kg while respondents in Dassa dislike relatively heavy chickens at the age of purchase. Respondents in Dassa were worse-off than those in Toffo when buying/keeping animals that are not robust but die when ill (difference of €13 per chicken). However, the 25th and 75th percentiles for this trait in the model for Dassa confirm that there are respondents who would be willing to pay for extra body weight. The trait "body weight" seems to have strong unobserved heterogeneity within the sample for Dassa, also supported by the greater magnitude of the coefficient for the standard deviation than the mean coefficient (Table 6).

4. Discussion

4.1. What matters: production, health or culture?

Drawing on the TEV approach, the results of the CE showed differences between preferences for direct and indirect use-values. Health and disease resistance, indirectly influencing productivity and income from chicken production, seemed to be of highest value. The highest welfare loss resulted from chicken breeds that are likely to die after illness. The two major poultry diseases, Newcastle disease and Avian Influenza, are particularly devastating to exotic commercial breeds. Although vaccine is available for Newcastle disease, availability and costs are likely to prevent many farmers from obtaining them. A household with an average flock size of 20 chickens that do not die due to disease would be approximately €70 (€10*7) better off than one whose chickens were vulnerable. Respondents in Dassa, in particular, cared about the disease resistance of chickens, with a very high WTP for chickens that become ill but survive and a very high WTA compensation for chickens that become ill and die.

Compared to the health status of chickens, farmers seemed to be less concerned about direct production benefits. Although farmers in Toffo derived about €3 per extra kg of animal, in Dassa, the trait body weight (at six months) had a negative impact on welfare. At the stage when they are sold (six months), the difference between indigenous and exotic chickens is about 1 kg. Farmers in Toffo would hence have a welfare gain of €3 per exotic chicken relative to an indigenous chicken and respondents in Dassa would have a welfare loss of €6.42 per exotic chicken. For an average-sized flock this amounts to a €60 welfare gain per year (€3*20) for respondents in Toffo and a loss of €128 (€6.42*20) for those living in Dassa.

This does not reflect the differences in market prices between an indigenous chicken and an exotic chicken when sold at the same age at the market but rather the difference in TEV of each additional kg for the two chicken types. The difference in market prices between the two types is only marginal and certainly not €3 per kg but the high value of each kg can be because of the cultural significance of having large animals or the capacity to raise sturdy animals in a harsh environment. Hatching frequency, another direct use-value, seems to have higher value for respondents in Dassa. A household in Dassa with an average flock size of 20 indigenous chickens that breed/hatch twice a year would gain €155 (€7.73*20) per year compared to 20 exotic chickens that hatch three times a year. This seems to be high; a household in Toffo in the same situation would gain only €38 (€1.90*20) per year from a flock of 20 indigenous chickens. This preference for lower hatching frequency may be related to higher mortality rates among those chickens that breed more frequently.

The cultural trait plumage colour had indirect use to farmers as well as some intangible non-use values which could be determined by the research. Discussions with respondents revealed that the colour was important for religious and cultural ceremonies. Exotic breeds are mainly white whereas indigenous chickens are mainly brown and/or black. Respondents have marginal welfare losses from black chickens of about €0.60 and from brown chickens between €1 (Model 1) and €9 (Model 2). An average flock of 20 exotic white chickens hence outperforms a flock of 20 indigenous black chickens by €12 and a flock of 20 indigenous brown chickens by €20 to €180. The difference in utility between white and colourful chickens differs between the two districts. Respondents in Dassa do not place any significance on the plumage colour and, unlike respondents in Toffo, do not suffer any welfare loss when keeping coloured indigenous chickens. It was surprising to find that brown chickens were so disliked, particularly in Toffo, because brown chickens are associated with food. However white chickens in Benin signify peace. The importance of keeping white chickens because of this association highlights the importance of cultural traits in breed choice and is also important for planning future conservation programmes. For this reason farmers may increasingly seek to breed with exotic white breeds both to breed out the disliked brown and black colour and because white chickens fetch the highest market price. However, introducing exotic breeds into flocks and finally breeding out the traits of indigenous breeds may eventually prove dangerous because of the reduced disease resistance and general poor adaptability of exotic chickens. In the long-run farmers are likely to suffer welfare losses.

4.2. Policy implications for breeding strategies and conservation

At present, the Benin Ministry of Agriculture, Livestock and Fisheries has no action plan for the management of chicken breeds (FAO, 2004) even though chicken are one of the eight government priorities in agriculture. As part of this priority chickens are brought in from foreign countries and scattered through the villages to be used for crossbreeding. This is a long-standing classical intervention scheme established by the government to meet farmers' demands. Farmers pay for this service. Indigenous chicken populations have been neglected in this ongoing programme or are seen as an impediment. However, the uncontrolled introduction of new genetic material may need to be modified in case crossbreeding with exotic breeds leads to full replacement of indigenous breeds, resulting in significant utility and welfare loss to farmers (as shown in the previous section). This welfare loss may increase. Farmers' needs for traits related to adaptability are likely to increase because of rapid global environmental change. This study has demonstrated that adaptive traits are very important and it is unlikely that breeds brought in by the government match farmers' utility from them. It is also unlikely that the current scheme takes into account cultural values that farmers have for chicken breeds.

Preferences for use (market) and non-use (non-market) traits can influence community livestock development and conservation programmes. If farmers have higher welfare from many traits that are expressed in exotic/commercial breeds, conservation of indigenous breeds will be difficult without compensating the farmers for their losses. This is the challenge with white exotic chickens. Most farmers preferred white over the colours of indigenous chickens and village development and conservation programmes could be adversely affected if farmers insist on keeping white chickens. White is preferred both as a symbol of peace and because it fetches high market prices. Conservation schemes would therefore have to compensate farmers who are willing to maintain brown indigenous chickens despite their lower TEV. However, because traits such as disease resistance are more strongly expressed in indigenous breeds than in exotic and crossbreeds, and farmers would have immediate incentives to keep them, promoting the qualities of indigenous breeds may be the best way to reduce mortality due to disease. Farmers have so much more utility from chickens that are disease resistant than from other preferred traits that they are likely to support conservation of indigenous breeds once they understand the trade-offs inherent in their choice. The ideal breeding programme would produce hardy white hybrids with the disease resistance of indigenous chickens.

Almost every household in rural Benin keeps chickens. The welfare gain for the whole society would be substantial if chicken production programmes based on indigenous chickens can be developed and implemented in such a way that every household gains, although transaction costs would be high for both the many participating households and the project managers. As preferences for traits vary greatly between the two research districts, conservation schemes should be specifically tailored for each district. Compensation does not necessarily have to be in monetary terms but an incentive scheme could also include, for instance, free vaccination or medicine for the chickens of households keeping only indigenous chickens. Less compensation needs to be paid when conserving indigenous chickens in the Dassa district, suggesting that a conservation programme with the participation of farmers in

Dassa would be more cost-effective than it would be if initiated in Toffo. Farmers in Dassa, a fairly remote area compared to Toffo, do not need compensation for not breeding white chickens, receive high welfare gains from disease resistant chickens and high welfare losses from chickens that die easily. These findings suggest that farmers in Dassa have almost enough incentive to keep indigenous chickens without compensation.

Given the large percentage of farmers not recognising the breed they keep, knowledge transfer and awareness raising of the advantages and disadvantages of certain breeds under certain environmental conditions would be a first crucial step towards village-based breeding and utilisation of indigenous chicken breeds. The problem of uncontrolled flow of chickens into a household's flock could be contained by setting up responsibilities within a household for controlling the inflow after some training about recognition of breeds. The skills needed to keep records of the number of indigenous chickens of different breeds in a flock could be transmitted by extension officers/ NGOs / state research farms.

5. Conclusions

Indigenous chickens, unlike intensively raised chickens, live and produce in diverse socio-economic and physical production environments. The study showed that chickens have values beyond production performance and growth, namely those related to religious beliefs and cultural ceremonies (peace) and the health status of animals. It is therefore important for extension agencies/ research institutes/ government to understand what functions and traits farmers value in their chickens and "what" they would like to breed to improve their livelihoods. Most farmers derived high utility from white chicken breeds, the colour commonly found in exotic breeds (e.g. the Leghorn) and hybrids because they are heavier and signify peace. This is a disincentive for establishing conservation programmes for brown indigenous chicken breeds and might discourage farmers from participating in a conservation programme. However there are also strong natural incentives for farmers to keep indigenous chickens and to participate in village chicken breeding programmes because many traits of high value are expressed in indigenous chickens (such a disease resistance). If compensation schemes do need to be established as part of village breeding/conservation programmes for indigenous chicken breeds, it is cost-effective to target farmers in Dassa. Farmers in Toffo seem to be more production driven and would hence have less utility from keeping less productive indigenous chickens. The ambition for productivity in Toffo is consistent with its proximity to Cotonou, where exotic chicken genetic material is readily accessible.

Two constraints were identified that are likely to further hinder selective breeding within a village breeding programme. One is the low percentage of farmers having deep knowledge about breeds beyond distinguishing between indigenous and non-indigenous. The other is that most households allow any household member to introduce new breeds. Both constraints need to be addressed by state research farms/ NGOs /extension agencies if village breeding programmes are to succeed. Greater investment in visits by extension services and state farm officers to train farmers in breed characterisation and flock management at the household level would be one way to overcome these constraints

Acknowledgments

We would like to thank the National Agricultural Research Institute of Benin (INRAB) and the International Livestock Research Institute (ILRI) for funding and collaboration. We are grateful for comments and advice on earlier drafts from Guy Apollinaire Mensah (INRAB) and from Jean-Claude Codjia (Faculty of Agricultural Sciences, University of Abomey-Calavi).

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Tables

Table 1: Level of threat to indigenous chicken breeds

Region	Proportion of breeds endangered (%)	Number of breeds endangered*	Number of breeds in total
Africa	5 - 60	3 - 33	55
Asia and the Pacific	20 - 66	25 - 84	128
Europe	64 - 75	309 - 360	479
Latin America and the Caribbean	40	14	35
Near East	26	7	27
North America	80 - 90	8 - 9	10
World	50 - 69	366 - 507	734

Source: FAO (2000); * the range is because of many breeds with unknown status

Table 2: Characteristics of study districts in Benin

	Dassa	Toffo
Location	7º46'N2º10'E	6º50'N2º5'E
Area (km^2)	1711	515
Climate	Dry; one rainy, one dry season	Wet; two rainy, two dry seasons
Principal economic activities	Cotton, cashews, soy beans, cattle, sheep	Palm oil, bananas
Population (no. people)	64,000	63,000
Targeted villages	Dewe, Gnonkpingnon	Houngo govè, Zèko bopa

Table 3: Attributes and levels used in choice experiment

Attribute	Levels
Disease resistance	1) rarely becomes ill 2) become ill but survive 3) become ill and die
Market price (in CFA per adult animal)	1) 1050 2) 1450 3) 2000
Body weight	1) 650 g 2) 900 g 3) 1150 g
Colour of plumage	1) Black 2) Brown (includes reddish) 3) White
Hatching frequency	1) Twice a year 2) Three times per year

Table 4: Household characteristics

Characteristic	Toffo	Dassa	Pooled data
Number of respondents	153	144	297
Male no. (%)	90 (59)	68 (47)	158 (53)
Female no. (%)	63 (41)	76 (53)	139 (47)
Average number of chickens	23.1	14.8	19.0
Proportion of indigenous chickens (%)	32	21	27
Average number of goats	2.8	2.0	2.4
Average number of cattle	0.03	0.30	0.20
Average km from nearest market	3.4	2.5	3.0
% of people keeping indigenous chickens	32	21	27
% of people using chickens for ceremony	37	67	51
Average number of chickens used per ceremony	2.2	2.3	2.3
Frequency of ceremonies per month	0.7	1.1	0.9
% literacy	25	60	56
Main occupation:			
- Crop production no. (%)	118 (77)	123 (85)	241 (81)
- Handicrafts no. (%)	31 (20)	18 (13)	49 (16)
- Livestock production no. (%)	4 (3)	3 (2)	7 (3)
Average income:			
- from chicken production	13,691 (21)	14,960 (23)	14,339 (22)
- from crop and livestock production CFA (€)	54,840 (84)	144,224 (220)	98,177 (150)

Table 5: Results of MXL models without (Model 1) and with socio-economic interactions (Model 2)

	Model 1		**Model 2**	
Chicken traits	**Coefficients**	**Std err.**	**Coefficients**	**Std err.**
Fixed parameters				
Opt-out constant (ASC)	-3.767**	1.560	-2.728**	1.374
Hatching frequency: Twice a year	2.374***	0.172	2.512***	0.189
Market price (CFA)	-0.001***	0.0002	-0.001**	0.0004
Random parameters				
Plumage colour: Black	-0.483***	0.170	-0.327*	0.188
Plumage colour: Brown	-0.679***	0.236	-4.929***	0.694
Disease resistance: Ill and die	-4.544***	0.924	-4.337***	0.732
Disease resistance: Ill and survive	4.710***	0.414	8.332***	0.816
Body weight (g)	0.002***	0.0004	0.004***	0.001
Interactions				
Brown plumage * **Toffo**			1.387***	0.450
Ill and survive * **Toffo**			-4.669***	0.692
Body weight * **Ceremonial use**			-0.002***	0.001
Brown plumage * **Indigenous chicken**			4.001***	0.602
Market price * **Indigenous chicken**			0.002***	0.0004
Standard deviations				
Plumage colour: Black	0.596**	0.298	0.932***	0.242
Plumage colour: Brown	0.928***	0.338	1.154***	0.377
Disease resistance: Ill and die	2.456***	0.800	2.830***	0.697
Disease resistance: Ill and survive	2.241***	0.395	1.849***	0.368
Body weight (kg)	0.003***	0.001	0.003***	0.001
Number of observations:		1782		1782
Number of respondents:		297		297
Number of Halton draws:		200		200
Log likelihood function:		-847.76		-742.87
Chi squared:		3245.23		3455.02
Adjusted R squared:		0.40		0.36

*** 1% significance level; ** = 5% significance level; * = 10% significance level

Table 6: Results of MXL models for Toffo and Dassa

	Toffo		Dassa	
Chicken traits+	**Coefficients**	**Std err.**	**Coefficients**	**Std err.**
Fixed parameters				
Opt-out constant (ASC)	-0.131	0.957	-15.760***	4.786
Hatching frequency: Twice a year	1.569***	0.155	5.284***	0.696
Disease resistance: Ill and survive	N/A		9.227***	0.995
Market price (CFA)	-0.001***	0.0002	0.001**	0.000
Random parameters				
Plumage colour: Brown	-0.358*	0.195	Not significant	
Disease resistance: Ill and die	-3.477***	0.585	-9.097***	2.873
Disease resistance: Ill and survive	2.593***	0.245	N/A	
Body weight (g)	0.002***	0.000	-0.004**	0.002
Standard deviations				
Plumage colour: Brown	0.678*	0.367	N/A	
Disease resistance: Ill and die	1.895***	0.580	2.802*	1.648
Disease resistance: Ill and survive	1.147***	0.310	N/A	
Body weight (kg)	0.002***	0.000	0.007***	0.001
Number of observations:		918		864
Number of respondents:		153		144
Number of Halton draws:		200		200
Log likelihood function:		-520.83		-213.77
Chi squared:		1503.58		1967.98
Adjusted R squared:		0.20		0.58

*** 1% significance level; ** = 5% significance level; * = 10% significance level

+ the traits “black plumage” was not significant and excluding it from the models increased the model fits

Table 7: Welfare estimates (WTP/WTA) for significant chicken traits

	Model 1		Model 2	
Attribute/Chicken trait	WTP/WTA in CFA	WTP/WTA in €*	WTP/WTA in CFA	WTP/WTA in €*
Plumage colour: Black - Median	**-473**	**-0.72**	**-363**	**-0.55**
25 percentile	-883	-1.35	-1110	-1.69
75 percentile	-79	-0.12	355	0.54
Plumage colour: Brown - Median	**-664**	**-1.01**	**-5717**	**-8.72**
25 percentile	-1303	-1.99	-6643	-10.13
75 percentile	-50	-0.08	-4828	-7.36
Disease resistance: Ill and die - Median	**-4502**	**-6.86**	**-5014**	**-7.64**
25 percentile	-6193	-9.44	-6496	-9.90
75 percentile	-2877	-4.39	-3590	-5.47
Disease resistance: Ill and survive - Median	**4747**	**7.24**	**9737**	**14.84**
25 percentile	3205	4.89	8335	12.71
75 percentile	6230	9.50	11,085	16.90
Body weight (per kg) - Median	**1588**	**2.42**	**4969**	**7.58**
25 percentile	-486	-0.74	2793	4.26
75 percentile	3584	5.46	7060	10.76
Hatching frequency: Twice a year - Median	**2377**	**3.62**	**2929**	**4.47**
25 percentile	2259	2.81	2777	4.23
75 percentile	2491	5.81	3075	4.69

* 1 € = 655.957 CFA francs (in 2006) (OANDA, 2009)

Table 8: Welfare estimates (WTP/WTA) for significant chicken traits – for different districts

	Toffo		**Dassa**	
Attribute/Chicken trait	**WTP/WTA (CFA)**	**WTP/WTA (€*)**	**WTP/WTA (CFA)**	**WTP/WTA (€*)**
Plumage colour: Brown - Median	**-274**	**-0.42**		
25 percentile	-644	-0.98	Not significant	
75 percentile	81	0.12		
Plumage colour: Black	Not significant		Not significant	
Disease resistance: Ill and die - Median	**-2727**	**-4.16**	**-10,370**	**-15.81**
25 percentile	-3760	-5.73	-12,580	-19.18
75 percentile	-1735	-2.64	-8246	-12.57
Disease resistance: Ill and survive - Median	**2069**	**3.15**	**10,593**	**16.15**
25 percentile	1443	2.20	9808	14.95
75 percentile	2670	4.07	11,347	17.30
Body weight (per kg) - Median	**1923**	**2.93**	**-4210**	**-6.42**
25 percentile	1042	1.59	-9541	-14.55
75 percentile	2771	4.22	915	1.39
Hatching frequency: Twice a year – Median	**1244**	**1.90**	**5069**	**7.73**
25 percentile	1160	1.77	5520	8.42
75 percentile	1325	2.02	6596	10.06

* 1 € = 655.957 CFA francs (in 2006) (OANDA, 2009)

Figures

Figure 1: Map of Benin

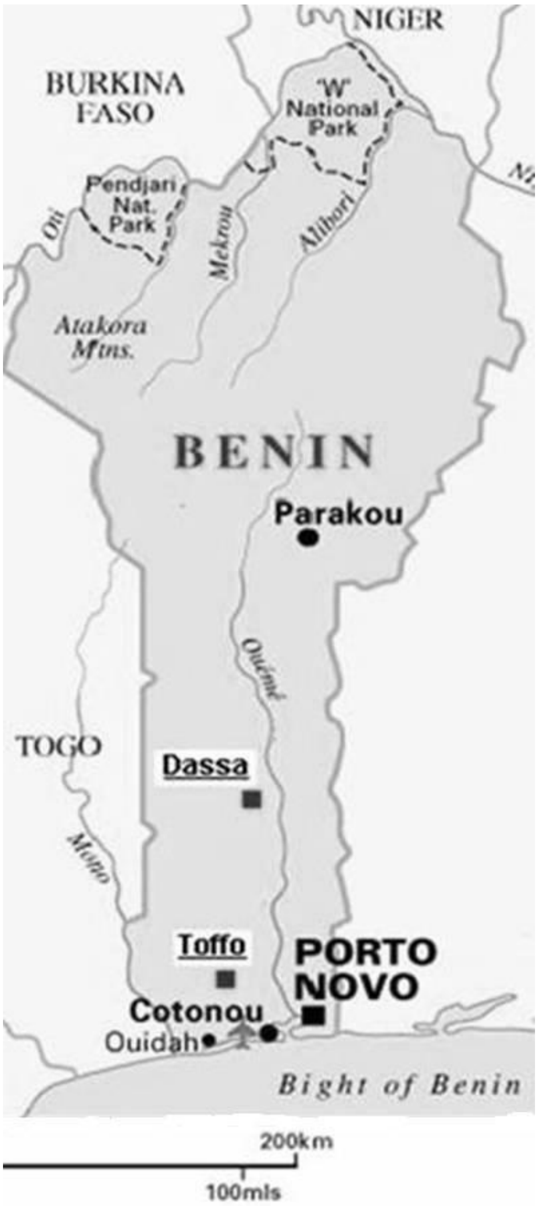

Figure 2: Example of a choice set