Ricebean Network

FOSRIN

Food Security through Ricebean Research in India and Nepal


Report 8: Hedonic price function for ricebean

Deliverable 1.1: Report on developing a Hedonic Price Function for ricebean

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Executive summary

The rural population in India and Nepal depend on a range of little known crops for their food security. There have been few efforts by scientists to improve the yield of these "orphan crops" by breeding. The potential role of orphan crops, using the example of ricebean, in improving the food security of rural poor in both countries was one focus of this project. To popularize ricebean and promote its usage, breeders aspire to develop an improved ricebean variety.

Usually, an improved variety should have higher yields but further improvements were desired for ricebean. Ricebean is highly heterogeneous in its appearance (colour, form and seed size) and also the insights gained from scientific articles about its nutritional composition were inconsistent. Thus, it was necessary to identify an instrument that reveals the relevant characteristics of ricebean to develop a variety which is accepted by Indian and Nepalese consumers. The benefit that the rural population would gain from an improved variety and the acceptance in markets would probably be enhanced by a ricebean variety with higher yield and meeting consumers' preferences.

The hedonic price analysis was chosen as an adequate instrument to determine the relevant characteristics at reasonable costs and time inputs. It has been applied several times to identify relevant characteristics of food, and also to derive implications for breeding. The hedonic price analysis assumes that price differences of products, such as ricebean emerge due to varying quantities of quality characteristics that are relevant for consumers. For the analysis 167 ricebean samples were collected on markets in India and Nepal. The influence of characteristics on market prices was estimated by multivariate regression analysis with price as dependent variable and the objectively measured characteristics as independent variables. Price and the independent variables were entered in logarithmic form. This allows interpretation of the calculated coefficients of significant characteristics as price elasticities. The price elasticity of a characteristic indicates the price change if the considered characteristic is increased by 1%.

Hedonic price functions were estimated for India and Nepal separately and for both countries combined. The samples of each country were analysed in laboratories within the country. The data of the two laboratories were combined but a dummy was inserted to allow the model to adjust for the differences. Further, a dummy was used to differentiate between samples from rural, semi-urban or urban markets. The hedonic price function for both countries could explain 60% of the price variations. Characteristics that significantly influence the price and that are relevant for consumers are seed size, and the content of crude fibre, protein and fat.

Use of this function would allow breeders to assess the expected price of an improved ricebean variety at an early stage, as quantities of 100 to 200 grams are sufficient to calculate the consumer preferences. Future prospects must combine both farmers and consumers requirements. An improved breed of ricebean could pave the way for an increase in yield and higher prices for better quality.

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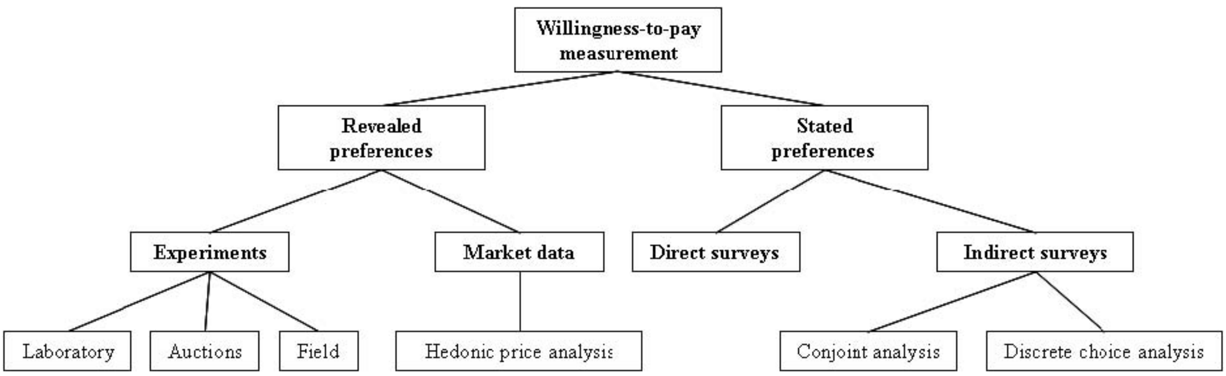
1. Introduction

There are many examples of less well-known plants, such as the ricebean (*Vigna umbellata*), which continue to be grown particularly in rural areas of developing countries, and thus contribute to the livelihood for small farmers, most of whom are poor. These species are known as 'orphan' or 'underutilised' crops. They are i) locally plentiful but globally rare, ii) there is little scientific information and knowledge about them available and iii) their current use is limited, relative to their economic potential (Gruere *et al*., 2007). Many of these orphans have a high potential to be improved by breeding as a mean of generating food and sustainable income for the local producers and chain actors.

Ricebean is one orphan crop has received little scientific attention with the consequence that no enhanced varieties exist. Thus, it has fallen far behind the major pulses regarding area and produced quantity in India and Nepal. Disadvantages such as low yield and high labour inputs in comparison to e.g., green gram (*V. radiata*) and black gram (*V. mungo*) have resulted in a decrease of areas planted with ricebean. Other documents in this series describe ricebean's distribution in Nepal and India (Gautam *et al*., 2007), indigenous knowledge on the crop (Khanal et al., 2009), molecular aspects (Bajracharya et al., 2008) and its importance in diets and nutrition (Andersen, 2009; Andersen *et al*., 2009).

There are several approaches to determine consumer's preferences for a particular item. These are shown in Figure 1.1. Consumer preferences are also referred to as willingness to pay. Willingness to pay can be quantified either through revealed or through stated preferences. Revealed preferences are obtained from price responses and stated preferences are taken from surveys and designed studies.

Figure 1.1: Classification of approaches to assess the willingness-to-pay.



Source: after Breidert (2006), p 37

Stated preferences in direct surveys are documented by directly asking consumers about their willingness-to-pay for a certain product whereas indirect surveys use ranking or sorting of products or product characteristics. Conjoint analysis and discrete choice analysis are two examples for indirect surveys.

The revealed preferences can be obtained from experiments and market data. Sources for market data can be panel data from consumer panels or store data from retail outlets. A necessary condition for the usage of market data is that the data contain price variations that cover the range of consumer preferences. The general advantage of market data is the usage of real purchase data instead of stated purchase intentions (Breidert, 2006; Wronka, 2004).

Product quality is defined as the sum of all evident and cryptic characteristics that influence the market price. At the same time price is determined by consumer preferences, consumer demand behaviour and market supply. Therefore, the quality of a product perceived by consumers depends upon the product's marginal utility for consumers. Thus, the purchase decision of consumers follows their preferences for products and product characteristics. Product preferences are reflected in prices under competition and therefore prices also include information about preferred characteristics.

In this study consumer's preferences were captured by estimating a hedonic demand function for ricebean which is explained in the next section. There were several reasons to choose the hedonic analysis from the great number of approaches to estimate consumer preferences. Firstly, the hedonic analysis uses revealed preferences that are based on real purchase data. Secondly, information about ricebean varieties and their characteristics was scarce because ricebean is an orphan crop. However, even if the ricebean had not been in the market it would have been possible to take close substitutes such as black gram (*Vigna mungo*), green gram (*V. radiata*) or cowpea (*V. unguiculata*). Finally, capturing consumer preferences is always constrained by time or money restrictions which influence the data collection. The hedonic price analysis was a suitable approach to estimate an index under the budget and time restriction of FOSRIN.

1.1 Literature review

Griliches (1971) analysed the impact that quality changes of automobiles have on price indices. He found, that at one point in time products (cars) are sold at different prices because of different characteristics, and showed that it was possible to derive implicit prices per unit of a chosen additional dimension of a good. These implicit prices for the 'whole' changed product could be interpreted as the price for its specification.

Rosen's (1974) theoretical analysis uses a plane of several dimensions to represent product quality. Locations in the plane are identified by vectors of coordinates $z = (z_1, z_2, z_3, z_n)$ where z_i measures the amount of the *i*th characteristic in the product. Studied products are described by *n* objectively measured characteristics and are completely described by numerical values of *z* that represent different packages of characteristics. Rosen assumed that a sufficient amount of differentiated products is available, so that consumers have a choice in various combinations of *z*.

The hedonic price analysis has been applied many times to identify characteristics of food which significantly influence the price. This was first done by Frederic Waugh (1928) when he found a relationship between changing qualities of asparagus and changing prices.

The study conducted by Ladd & Suvannunt (1976) aimed to develop a consumer goods characteristics model with retail prices per pound. They found a willingness to pay for energy and protein and a willingness to avoid phosphorus, iron and vitamin C.

As the hedonic price analysis provides implicit prices for characteristics of a product it is possible to identify consumer-relevant characteristics that can be used to improve varieties by breeding. Von Oppen (1978) was the first to define plant breeding goals by applying hedonic estimation. He developed a preference index to evaluate the acceptance of new food grains.

Unnevehr (1986) used implicit prices of grain characteristics to evaluate rice-breeding goals in Thailand, Indonesia and the Philippines. She used the model from Ladd and Suvannunt, which implies that all products are consumed for the utility they provide and that the utility depends on the characteristics of a product. Rice samples were collected of each rice grade sold by a retailer combined with name and price. Afterwards the samples were analysed in a laboratory. The implicit prices of the grain quality characteristics represent the change in rice price if the considered characteristic changes for one unit. Determined results were that the demand for milling quality is similar in Thailand, Philippines and Indonesia but demand for grain shape and some chemical characteristics, such as per cent share of amylose, varies. Therefore international breeding should concentrate on good milling quality and reduced amylose content.

Altemeier *et al.* (1989) analysed the relationship of quality characteristics and price of maize, soybean, and groundnut by estimating a hedonic price equation for different market levels in Indonesia. Altemeier observed preferences for well-dried (low moisture content) and clean maize. Soybeans are also more preferred when they are well dried but there seems to be no preference for cleaned soybeans. Groundnuts should be large, well dried and clean to meet consumer's preferences.

Brockmeier (1993) analysed German fruit juice. The following explanatory variables were used: calories, mineral nutrients and vitamins. In addition variables for flavours and returnable or nonreturnable packaging were included. Prices of 131 fruit juices were documented. By using regression analysis, 81% of the price variation could be explained through the chosen characteristics. The study revealed that consumers have a negative willingness to pay for minerals, they prefer energy in form of kcal and vitamins and consumers like non-returnable packages more than returnable.

Pecher (2000) studied the significance of quality and consumer preferences for breeding of barley. In her study 121 barley samples were collected in Syrian wholesale markets together with their respective prices. The relation of quality and price was assessed using multiple regression analysis and a hedonic price function was estimated. In Syria barley is used as fodder for sheep and as seed. Therefore the utility depends on forage quality, seed quality, local adaptation and key characteristics like colour. The hedonic price function proved that characteristics which influence the quality positively are also preferred by consumers. These characteristics were: crude protein, 1000 seed weight and loose awn. Broken or empty grains were found to affect price negatively. Further, preferences for barley varieties differ between peasants from west and east Syria.

Jiménez-Portugal (2004) investigated bean lots in Mexico and established relationships between price and quality characteristics. The quality characteristics that were detected to be significant relative to price were moisture content, cooked protein, carbohydrates digestibility, hectolitre, dry weight and non shrunken beans. Data were first collected through 370 consumer interviews in five different market locations to detect purchase habits, price awareness, bean preferences, methods for preparing beans and favoured quality characteristics of beans. In a second run, 380 bean samples were collected and analysed for evident and cryptic characteristics.

The hedonic price analysis has been applied successfully to i) determine the quality characteristics that significantly influence price and to ii) estimate implicit prices of evident and cryptic characteristics. There, are also many studies that analysed quality characteristics of food, perishable such as asparagus and durable such as rice, maize and soybeans.

1.2 The hedonic equation

The central idea of the hedonic price analysis is that goods are valued by consumers for their utility deriving characteristics (Lancaster, 1966). Hence, consumers are not evaluating the good itself but the characteristics of goods and demand is a function of product characteristics, not of the product. The demand for a special characteristic is revealed through the demand for a product that contains this characteristic. Therefore, if the amount of the characteristic demanded changes, the product prices will change too (Brockmeier, 1993).

A typical hedonic price function (F 1) assumes that the product price is determined by its product characteristics and could be specified as follows:

$$\textbf{F 1: } p_i = f(z_{i1}, z_{i2}, z_{i3},..., z_{im})$$

where f represents the functional form that is applied and z_{ij} is the quantity of characteristic j (j = 1,2,..n) that one unit of product i contains. The equation can be estimated with empirically determined price data and characteristics of product varieties. The implicit price also referred to as shadow price of a characteristic can be derived from the estimated hedonic function. The implicit price of a characteristic, such as protein, is obtained from the partial derivative of the hedonic function with respect to the particular characteristic.

$$\textbf{F 2: } \frac{\delta p_i}{\delta z_{ij}} = p_j(z_{i1}, z_{i2},..., z_{in})$$

Rosen (1974) defined hedonic prices as implicit prices of product characteristics that are revealed to consumers from the prices of diverse products that are varying in specific amounts of characteristics. Further, characteristics have implicit prices in competitive markets because consumers evaluate the characteristics by purchasing the product with the desired attribute. Thus, the market price of a product is the sum of all the implicit prices of the quality characteristics.

The implicit price *pj* of a characteristic allows a statement about the increase of the product price if the amount of characteristic *j* increases under *ceteris paribus* conditions. The absolute price change could be calculated by multiplying the absolute change in the characteristic's level with the implicit price.

An econometric estimation of a hedonic price function provides the following possibilities: i) to get an impression about the magnitude of implicit prices of studied characteristics, ii) to calculate the price variation caused by marginal and absolute variation in the amount of characteristics, and iii) to estimate the price of new products that are product variations of already existing products by assessing the implicit prices of characteristics and multiplying these prices with the amount of the considered characteristics (Brockmeier, 1993).

1.3 A hedonic price model for ricebean

A general superior form of the hedonic price function can not be derived from the economic theory. Most of the empirical applications use simple functional form such as, linear, semi-log, double-log or linear Box-Cox-forms (Wronka, 2004). The advantage of these simple function forms is that they are less prone to missing variables and to the usage of proxy variables (Cropper, *et al*. 1988).

For the hedonic price function of ricebean a double-log function was chosen because characteristic's coefficients can be interpreted as their elasticities. Thus, the results can be used as an index for breeders to asses the value of a new ricebean variety *ex ante*.

1.4 Determinants of ricebean quality

As described in the beginning of this section, goods are valued by consumers because of their utility-deriving characteristics. Thus, the quality or value of a whole good depends on its individual characteristics. The quality of a specific item as evidenced through consumers acceptance and purchase is not determined by a few visible characteristics (evident). It is more a complex composition of several traits where many of them are not visible (cryptic) (Von Oppen, 1978).

Characteristics of beans which influence the quality and therefore the value for consumers can roughly be separated into two groups, evident and cryptic characteristics. Evident traits like colour or shape are visible to consumers whereas cryptic traits are not visible and can only be judged after consumption. Examples of cryptic traits are composite ingredients such as fat or protein and culinary qualities like swelling capacity. Both types of characteristics, evident and cryptic, are related to each other. In consequence, consumers evaluate evident characteristics, by inferring to certain cryptic characteristics. For instance, it is widely known that a really green apple will taste sour whereas, red or yellow apples tend to be sweet (Jiménez Portugal, 2004).

2. Methodology

2.1 Quality traits

The perfect hedonic price function contains information about all characteristics that influence the price. Thus, it is important to review vast literature to reveal the relevant characteristics for legumes. This study included characteristics of pulse composition and preparation. The characteristics in Table 5 were chosen after reviewing articles concerning the nutritional composition of ricebean as well as characteristics affecting domestic processing and cooking (Jiménez Portugal, 2004; Kaur & Kapoor, 1990b, 1992; Malhorta *et al.,* 1988; Patwardhan, 1962; Reyes-Moreno *et al*., 2000; Tharanathan & Mahadevamma, 2003).

After choosing the traits that should be assessed chemical analyses were selected. Therefore a catalogue provided by the AOAC (Association of Official Analytical Chemists) was used (Cunniff, 1995). It was important to choose one standard method as it was not sure if all samples could be analysed in one laboratory. Further, the methods had to be adequate for relatively simple equipped laboratories in developing countries, such as India and Nepal.

As, it was not possible to exchange ricebean between India and Nepal officially, one laboratory in each country was used. The analysis in Nepal was conducted in the lab of a project partner, Li-Bird in Pokhara. In India, the samples were analysed at the Agricultural University in Anand, Gujarat.

Table 2.1: Selected characteristics for the hedonic price analysis.

Characteristic	Units	Classification
Moisture	%	Cryptic
Protein	%	Cryptic
Fat	%	Cryptic
Crude fibre	%	Cryptic
Carbohydrate	%	Cryptic
Ash	%	Cryptic
Seed weight	g	Evident
Foreign matter	%	Evident
L/B ratio	Index	Evident
Water up-take capacity	%	Cryptic
Swelling capacity	%	Cryptic
Colour diversity index	Herfindahl index	Evident

Table 2.1 gives an overview of the quality characteristics that were quantified in the laboratories. Fractions of each sample were ground before the nutritional components (moisture, protein, fat, crude fibre, and ash) were assessed. The moisture content depicts the remaining water in the seeds. A high value for this trait is often disliked by consumers because good quality ricebean is carefully dried in the sun and freshly harvested seeds have considerably higher water content (Altemeier *et al*., 1989). Another important component for the inhabitants of developing countries is protein because many Indians and Nepalese are vegetarians and proteins from animal products are more expensive than proteins from plant products. The protein content was measured as crude protein with the Kjeldahl analysis (CP =

total N x 6.25). The fat was determined by solvent extraction. The digestible carbohydrates were calculated based on of the Weender analysis. Because moisture, fat, protein, ash and crude fibre are determined as percentages they can be subtracted from 100%. The remaining part contains digestible carbohydrates (Asp, 1994). Crude fibres are carbohydrates, but cannot be fully digested in the human intestine. Ash denotes the quantity remaining after the sample was burned in a funnel: it does not contain any organic material, but only minerals such as iron, zinc or copper.

The weight of 100 seeds is used as an indicator for the seed size. The cleanliness or purity was determined by weighing the sample with and without dirt referred to as foreign matter. Dirt and foreign materials include small stones, other pulses and broken/ destroyed beans. The foreign material corresponds to the share which would be removed before soaking or cooking ricebean. Ricebean form was measured by the length to breadth ratio. A value of 1 would reveal a round form because length and breath are equal. The water uptake measures the weight increase after soaking. Ricebean like other pulses is soaked over night before cooking; thus it is an important processing trait. Apart from weight increase also the swelling capacity documents the effect of soaking on volume increase. Both traits were quantified with a sample size of around 100 seeds rather than with single seeds. The advantage is that both characteristics can reveal the number of hard seeds. Hard seeds are definitely not preferable because their seed coat is impermeable to water. Such seeds do not swell and often stay hard even after cooking (Reyes-Moreno *et al.,* 2000).

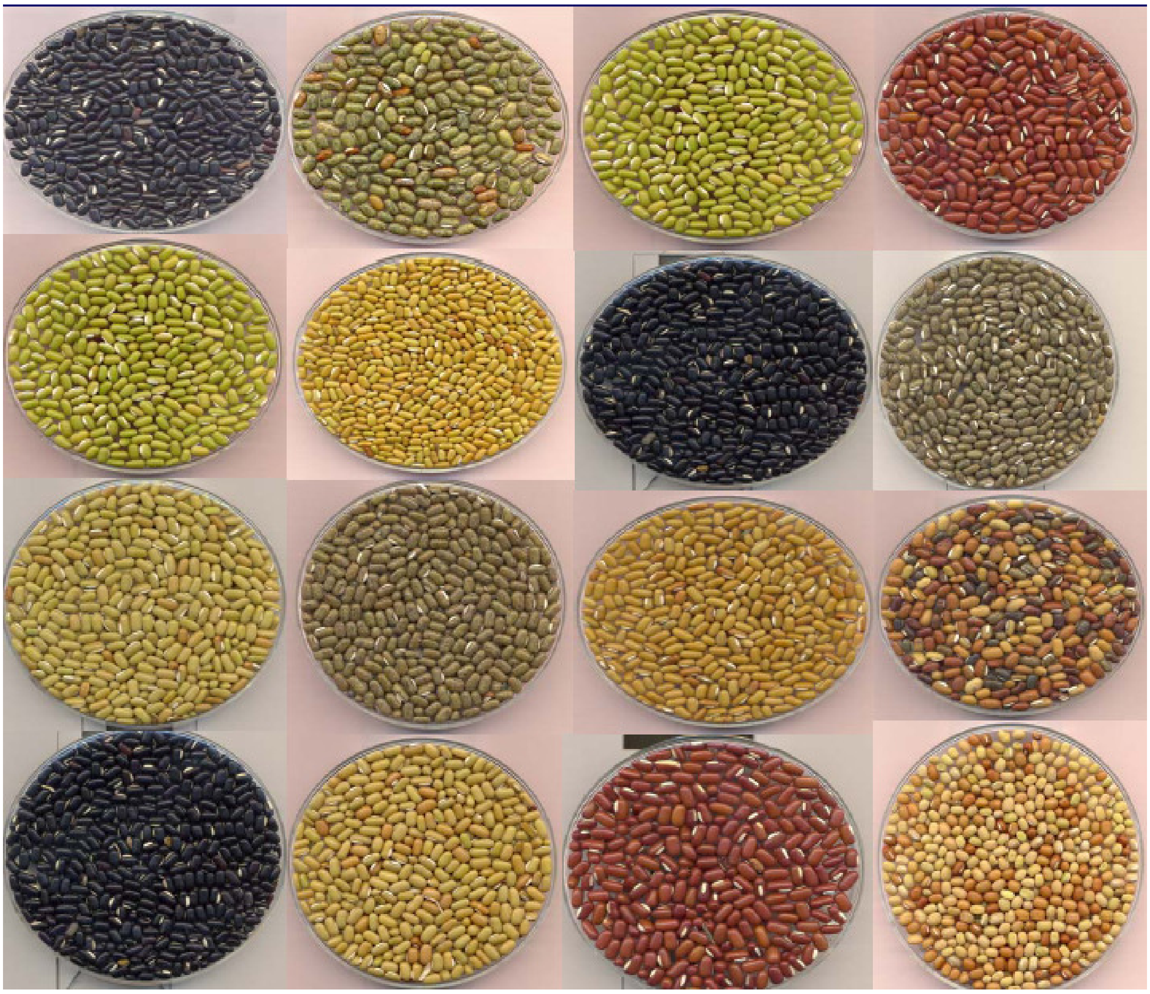


Figure 2.1: Colour diversity of ricebean.

Source: Dua *et al*., 2010

The characteristic colour was considered as colour diversity index. Figure 2.1 gives an impression of possible colours of ricebean. The different colours prevalent in each sample were measured as percent share to identify preferred colours and to determine whether consumers prefer either mixed coloured or single-coloured lots of ricebean. This preference is assessed by a colour diversity index. Usually ricebean is offered in bags at the markets and consumers will find, e.g. pure black, yellow and grey ricebean or they find all or some of these colours mixed together in one bag.

Several diversity indices that are used in scientific fields such as ecology are available. The simplest way to measure diversity would be to count the different colours but that does not consider the frequency i.e., the per cent share of each colour is ignored (Drescher, 2007). The Herfindahl-Index (*HI*) (F 3) is often used to determine industrial concentrations (Patil & Taillie, 1982). It is calculated as the sum of the squares of colour shares of each sample (Drescher, 2007). The Herfindahl-Index (*HI*) is defined as follows:

$$\textbf{F 3:}\ HI = \sum_{i=1}^{n} s_i^{\,2}$$

where s_i is the relative abundance of the *i*th colour (e.g., black) in the sample containing *S* colours (Mouillot & Leprêtre, 1999). It ranges from 1/*n* to 1, whereas the maximum value of 1 indicates total concentration i.e., the sample consists only of one single colour (Drescher, 2007).

The Simpson or Berry-Index (*BI*) (F 4) is closely related to the Herfindahl-Index as their indices are reversions of each other. The Berry-Index ranges from 0 to 1-1/*n*, whereas 0 indicates no diversity in colour and 1-1/*n* means equal distributed colours.

$$\textbf{F 4:}\ BI = 1 - \sum_{i=1}^{n} s_i^{\,2}$$

Economists use the Berry-Index to determine industrial concentrations and ecologists apply it as the Simpson-Index to estimate diversities of species (Patil & Taillie 1982).

The third diversity index (F 5) is the Entropy-Index (*EI*), which is defined as follows:

$$\textbf{F 5:}\ EI = \sum_{i=1}^{n} s_i \ln\left(\frac{1}{s_i}\right)$$

Values of *EI* range between zero and ln(*n*), whereas the value of zero results when the share of a colour equals one which reveals unequal distribution. Thus, the maximum value of ln (*n*) presents total equal distribution (Lee & Brown 1989).

Another but very similar diversity index is shown in F 6, the Shannon-Index (*H*) (Mouillot & Leprêtre 1999).

$$\textbf{F 6:}\ H = -\sum_{i=1}^{n} s_i \log(s_i)$$

This review of diversity indices does not claim to be complete. Several indices like Gatlin's-Redundancy-Index, Camargo-Evenness-Index, Pielou-Regularity-Index or the Gini-Coefficient have also been used to determine diversity but it is not necessary for our purpose to enter into a detailed explanation of all of these methods. The Herfindahl-Index was chosen because it cannot take the value zero. This is important since the metric variables enter the regression in log form.

2.2 Data collection: ricebean samples

This section describes the procedure for sample collection. This includes the selection of investigated areas and the distribution of samples in Indian and Nepalese districts. Ricebean is planted in June-July and the harvest season is from October to November. The sample collection in India and Nepal had to be organised within a restricted time period to ensure comparable qualities and the availability of ricebean in the markets.

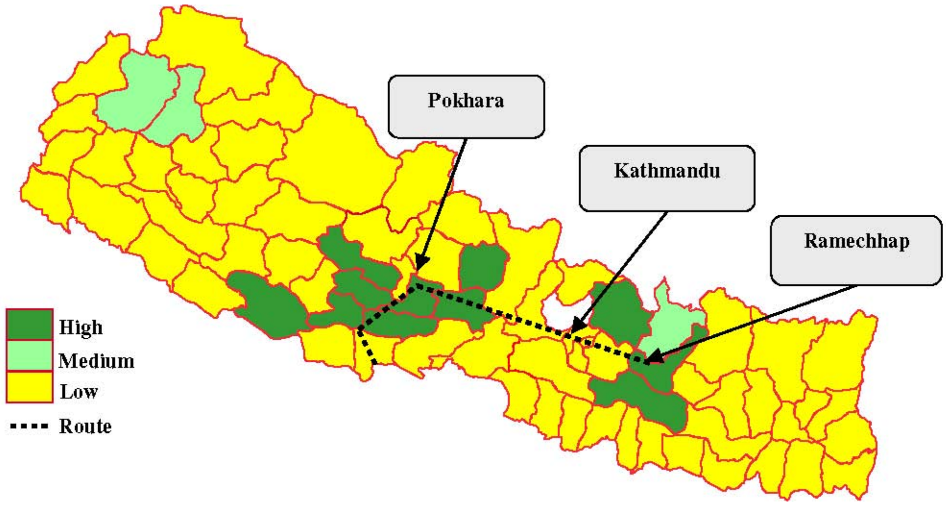


Figure 2.2: Ricebean distribution in Nepal (by area coverage) and sampling route.

Source: Gautam 2007

All samples were collected between January 10 and March 9, 2008. Each sample contained about 250 grams of ricebean which was enough to conduct all chosen laboratory analyses. The locations investigated were selected through a distribution report provided by the Nepalese and Indian partners of the project (Gautam, 2007).

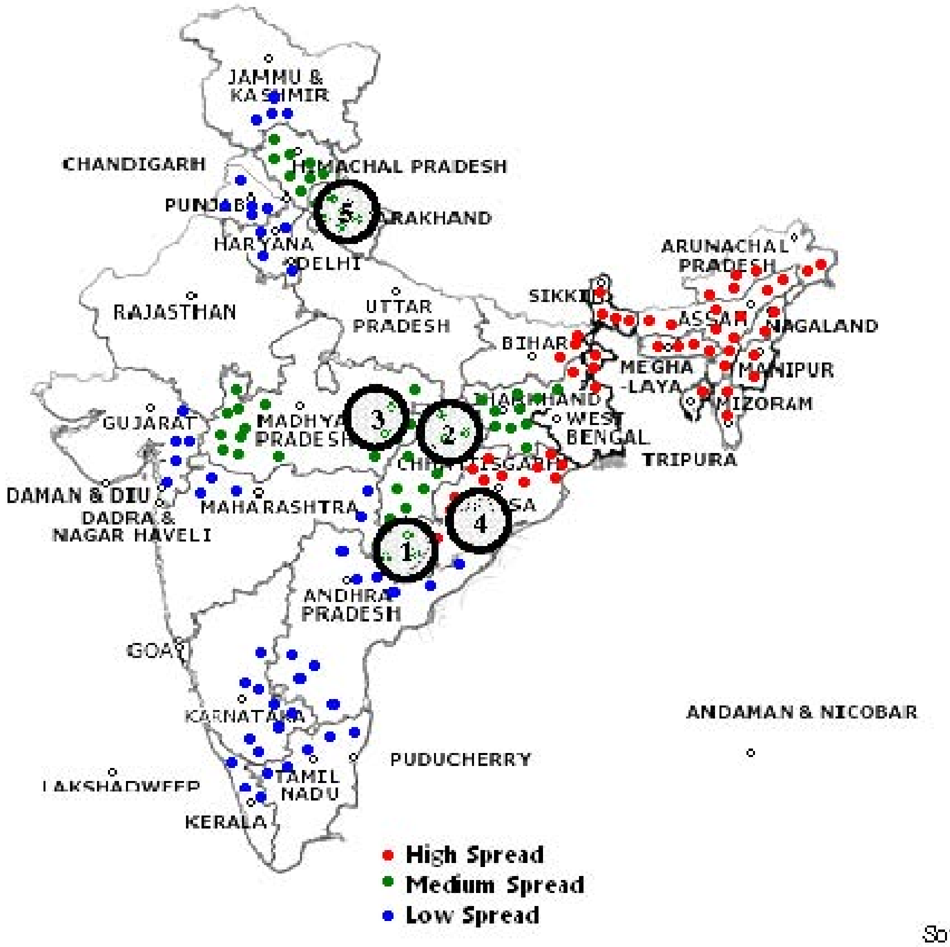
The sample collection began in Ramechhap, Nepal, located in the east of the country (Figure 2.2). The complete route can be reconstructed by following the black dotted line in Figure 3 from the right to the left. Altogether 14 markets were visited in 9 districts (Table 2.2) to collect 114 ricebean samples.

Table 2.2: Samples per district in Nepal.

District	Frequency	%
Dolakha	3	3
Palpa	3	3
Nawalparasi	4	4
Syangja	5	4
Dhading	10	9
Chitwan	15	13
Tanahun	15	13
Ramechhap	22	19
Rupandehi	37	32
Total	**114**	**100**

In India, 53 ricebean samples were collected in three states (Figure 2.3): Chhattisgarh, Orissa and Uttarakhand. The samples come from 16 markets in six districts. The first were collected in Chhattisgarh, and the two main areas are marked with black circles with the numbers ‘1’ and ‘2’ within them. Madhya Pradesh is labelled ‘3’. The research in the east of Madhya Pradesh was unsuccessful because ricebean was not available in the markets and only ricebean-growing farmers were found. Orissa on the East coast of India is marked ‘4’. The last station, ‘5’ was Uttarakhand in the North.

Although, the North East of India shows a high spread of ricebean, it was not possible to do research there for security reasons. Even, in Chhattisgarh the work was hampered by Naxalite riots, a revolutionary communist movement who prevented access to remote areas and markets.



Source: Gautam 2007

Figure 2.3: Ricebean distribution in India and sampled locations.

Table 2.3 shows the number of samples taken from each district. We found more market places and stores in which ricebean was available in districts in the states Orissa and Uttarakhand. The distribution of ricebean in Chattisgarh was lower than in Orissa and Uttarakhand.

Table 2.3: Samples per district in India.

District	Frequency	%	State
Dhamtari	1	2	Chattisgarh
Bastar	5	9	Chattisgarh
Khandhamal	8	15	Orissa
Dehradun	9	17	Uttarakhand
Theri Garhwal	10	19	Uttarakhand
Koraput	20	38	Orissa
Total	**53**	**100**	**3**

3. Results

3.1 Ricebean prices and characteristics

The price of ricebean samples is the most important market information collected together with a sample. It represents the dependent variable in the hedonic function. Prices in competitive markets reflect the degree to which consumers prefer product varieties, such as ricebean varieties. The following section provides detailed information about the samples collected in Nepal and India, first separately and later combined.

3.1.1 Nepal

The price range of ricebean samples can be explained as a function of qualities of ricebean. Samples with lower prices are visibly related to bad evident characteristics which are further related to cryptic characteristics. But as agricultural production is rather located in rural and remote areas instead of proximity to cities the price is also influenced by the market location. To characterize market locations, all markets included in the study were characterized as rural, semi-urban or urban. The population density in persons/ km² was used to classify districts in which the markets are located as rural, semi-urban or urban. The population density of each district in this study is shown in Table 3.1. As all markets were scrutinized personally it was also possible to differentiate between villages and small towns, if these were located in the same district. A market in a region with a population density under 150 persons/ km² was defined as rural, semi-urban markets were defined where a population density was over 150 to 250 persons/ km² and urban markets were located where the density was over 250 persons/ km².

Table 3.1: Population density of sampled districts in Nepal.

Market	District	Population density (persons/km²)	Classification
Adamgath	Chitwan	213	Semi-urban
Mugling	Chitwan	213	Semi-urban
Malekhu	Dhading	176	Semi-urban
Charaundi	Dhading	176	Semi-urban
Charikot	Dolakha	93	Rural
Pragatinagar	Nawalparasi	260	Urban
Aryabhenjyng	Palpa	196	Semi-urban
Randi	Palpa	196	Semi-urban
Ramechhap	Ramechhap	137	Rural
Butwal	Rupandehi	521	Urban
Syangja Bazaar	Syangja	273	Urban
Badhkhola	Syangja	273	Urban
Abukhaireni	Tanahu	204	Semi-urban
Damauli	Tanahu	204	Semi-urban

Source: Government of Nepal 2003

It can be assumed that ricebean found in urban markets are cultivated in rural areas and then traded via wholesalers or commission agents to retailers in cities. Thus, this classification of markets is a way to avoid that price differences based on transport and transaction costs are confounded with price differences due to quality differences (Buergelt *et al.*, 2009). Figure 3.1 shows that prices in rural areas are lower than in semi-urban and urban areas. The highest mean prices are found in urban areas, cities like Butwal or Syangia Bazaar.

The prices of the 108 ricebean samples from Nepal vary over a range of 40.00 Nepalese Rupees (NPR)/kg, whereas the minimum is 25.00 NPR/kg and the maximum is 65.00 NPR/kg (Table 3. 2). The highest moisture content of 15.5 % could be a sample that was not well dried. The protein content also varies to a great range, the mean value however, of 24.7

% is also found in the literature (Dutta *et al.*, 2000). The fat content of ricebean is very low with a mean of 0.3 % in all samples. The variation of crude fibre, carbohydrates and ash is not peculiar and the mean values are similar to the ones reported in the literature (Malhorta *et al.*, 1988). The seed weight reflects the seed size because 100 large seeds have a higher weight than 100 small seeds. The seed weight differences are reasonable as the size of ricebean varies greatly (Figure 2.1).

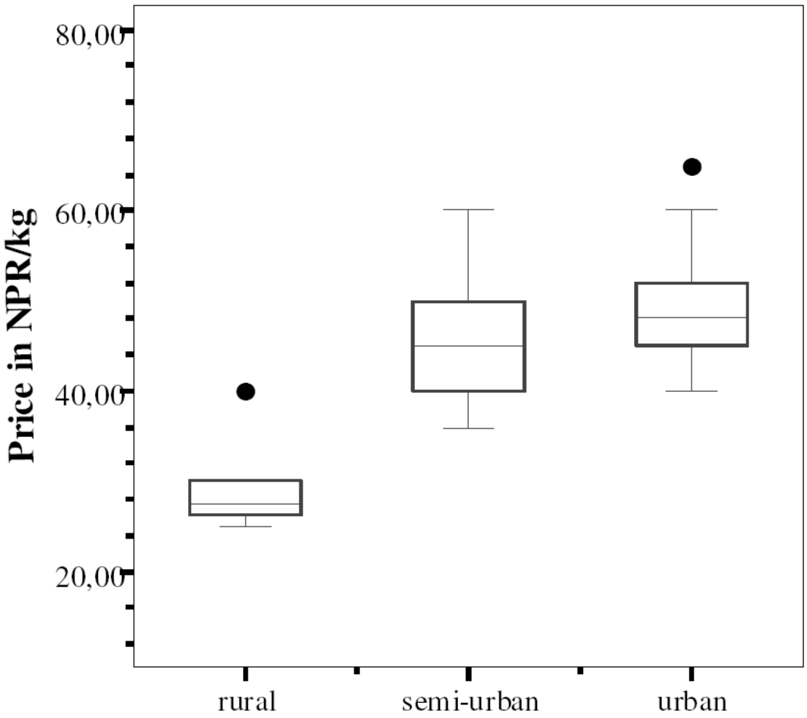


Figure 3.1: Price levels in sampled rural, semi-rural and urban areas in Nepal, January to March 2008.

Table 3.2: Descriptive statistics of Nepalese samples (n = 108).

Characteristic	Unit	Minimum	Maximum	Mean	SD
Price	Nepalese Rupees per kg	25.00	65.00	43.52	10.03
Moisture	%	8.2	15.5	10.5	1.1
Protein	%	18.8	32.2	24.7	3.1
Fat	%	0.1	0.5	0.3	0.1
Crude Fibre	%	3.6	5.5	4.4	0.4
Carbohydrates	%	58.1	72.0	66.4	3.1
Ash	%	3.5	4.9	4.2	0.3
Seed weight	g/100 seeds	5.8	19.4	10.3	3.1
Foreign matter	%	2.3	19.3	8.1	3.5
LBRatio	Ratio length to breadth	1.4	2.1	1.6	0.2
Water uptake ratio	Ratio of weight increase	1.7	2.2	2.0	0.1
Swelling capacity ratio	Ratio of Volume increase	1.0	1.2	1.1	0.0
Colour diversity	Herfindahl-Index	0.3	1.0	0.6	0.2

The content of foreign matter is not a characteristic of ricebean itself but as the values show, the dirtiest samples contained nearly one fifth of foreign matter, which affects consumer perceptions while purchasing ricebean. The L/B ratio of Nepalese samples shows that the beans have an elongated form with a mean value of 1.6. The mean water uptake ratio of 2.0 indicates that the samples double their weight when they are soaked overnight. The comparison with swelling capacity ratio shows that the volume increase induced by soaking is less than the weight gain.

The colour diversity ranges from 0.3 to 1.0, whereas 1.0 indicates that the sample only contains one colour. Thus, the lower the Herfindahl-Index the more colours are present in a sample. Table 3.3 gives an overview of the colours represented in the samples. Zero values mean that that colour was missing in at least one sample. Pure samples of one colour were only found for brown and yellow, indicated by the maximum value of 100. The mean values show that yellow is the most frequent colour found across all samples and black is the least frequent one.

Table 3.3: Colour variation of ricebean samples from Nepal (n = 108).

Colour	Minimum	Maximum	Mean
Black	0	49	2
Brown	0	100	14
Grey	0	83	10
Olive	0	93	10
Red	0	94	6
Yellow	0	100	57

3.1.2 India

Table 3.4: Population density in sampled districts in India.

Market	State	District	Population density per km^2	Classification	Population of town/village
Dhamtari	Chattisgarh	Dhamtari	209	Urban	82.111
Lohandiguda	Chattisgarh	Bastar	87	Rural	0
Kunduli	Orissa	Koraput	134	Rural	1.675
Sunabeda	Orissa	Koraput	134	Urban	58.884
Koraput	Orissa	Koraput	134	Urban	39.548
Pukali	Orissa	Koraput	134	Rural	2.491
Semiliguda	Orissa	Koraput	134	Rural	91
Phulabani	Orissa	Kandhamal	81	Urban	33.890
Tikabali	Orissa	Kandhamal	81	Semi-urban	3.313
Bhanya Nagara	Orissa	Kandhamal	81	Rural	n.a.
Dehradun	Uttarakhand	Dehradun	415	Urban	530.263
Doiwalla	Uttarakhand	Dehradun	415	Semi-urban	8.043
Chamba	Uttarakhand	Tehri Garhwal	148	Semi-urban	6.580
Ranichhauri	Uttarakhand	Tehri Garhwal	148	Rural	n.a.
Baurari Chak	Uttarakhand	Tehri Garhwal	148	Rural	4
New Tehri	Uttarakhand	Tehri Garhwal	148	Semi-urban	25.423
Diwara	Uttarakhand	Tehri Garhwal	148	rural	173
Nail	Uttarakhand	Tehri Garhwal	148	rural	131
Agrakhal	Uttarakhand	Tehri Garhwal	148	rural	n.a.

Source: Census of India 2001

The categorization of Indian ricebean markets (Table 3.4) was not as clear as in Nepal, so population data for towns and villages were added. For example, there are four markets in district Koraput. The population density of the district would classify all four as rural but a town like Koraput with nearly 40,000 inhabitants is urban rather than rural. The numbers of inhabitants of towns or villages were taken from the Census of India 2001. Figure 3.2 depicts the price levels of 45 samples in rural, semi-urban and urban areas in India. Similar to Nepal, the price levels in Indian rural areas are lower than in semi-urban areas and urban areas have the highest prices.

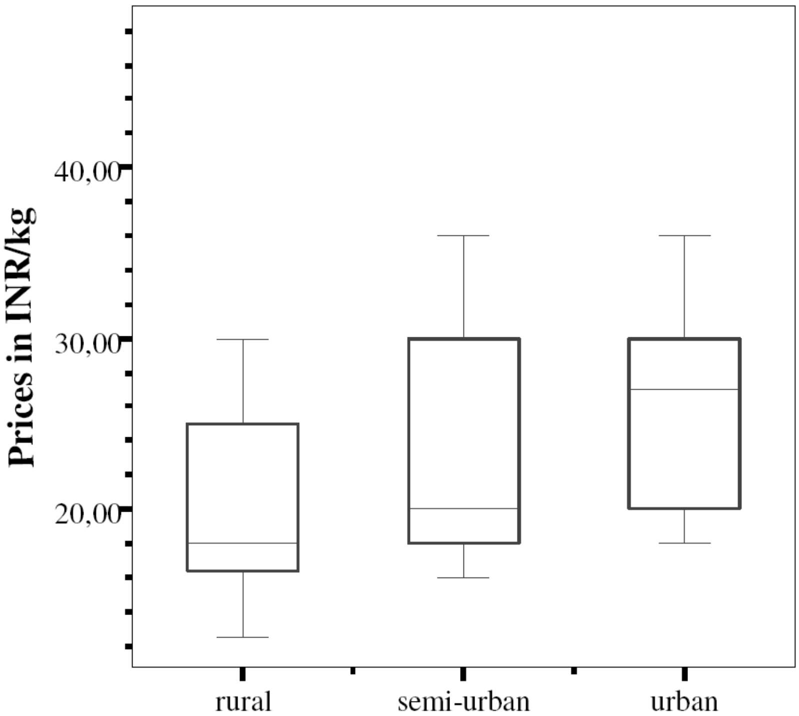


Figure 3.2: Price levels in sampled rural, semi-rural and urban areas in India, January to March 2008.

Table 3.5 summarizes characteristics of 45 samples from India. The price range of these is 23.50 Indian Rupees (INR)/kg. The maximum price is three times as high as the minimum, reflecting the impact also of location of the market in rural or urban areas. All other characteristics are quite similar to those described for Nepal.

Table 3.5: Descriptive statistics of Indian samples (n = 45).

Characteristic	Unit	Minimum	Maximum	Mean	SD
Price	Indian Rupees (INR)/kg	12.50	36.00	22.55	6.39
Moisture	%	8.1	12.8	9.8	1.1
Protein	%	14.5	21.6	17.9	1.7
Fat	%	0.4	0.8	0.6	0.1
Crude Fibre	%	4.1	7.0	5.3	0.9
Carbohydrates	%	59.6	66.0	62.2	1.6
Ash	%	2.4	5.1	3.7	0.7
Seed weight	g/100 seeds	4.1	13.6	6.9	2.5
Foreign matter	%	1.1	7.4	4.1	1.4
LBRatio	Ratio length to breadth	1.4	1.9	1.7	0.1
Water uptake ratio	Ratio of weight increase	2.0	2.2	2.1	0.0
Swelling capacity ratio	Ratio of Volume increase	1.6	2.0	1.8	0.1
Colour diversity	Herfindahl-Index	0.3	0.9	0.5	0.2

Table 3.6 shows the colour variation of the Indian samples. The most frequent colour is yellow with a mean share of 57% in all Indian samples followed by brown and olive with 18 %. Grey is the least frequent colour with a mean share of 0.04%.

Table 3.6: Colour variation of ricebean samples from India (n = 45).

Colour	Minimum	Maximum	Mean
Black	0	30	4
Brown	0	63	18
Grey	0	2	0
Olive	0	60	18
Red	0	20	3
Yellow	20	95	57

3.1.3 Comparison of the samples from Nepal and India

The Indian Rupee (INR) is used as a standard currency to combine and compare Nepalese and Indian ricebean samples. Figure 3.3 depicts the price levels of rural, semi-urban and urban areas in India and Nepal, whereas rural areas have the lowest and urban areas have the highest prices.

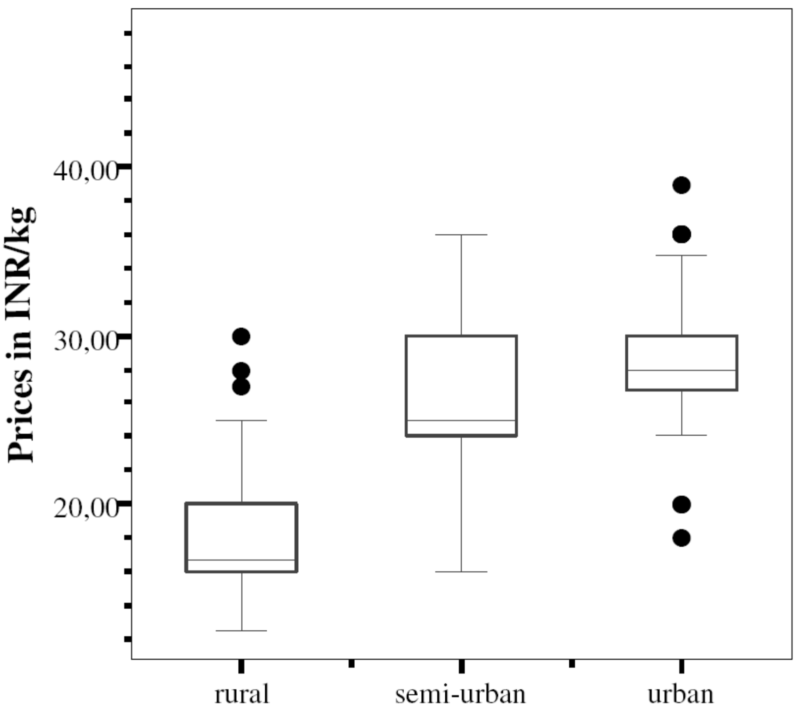


Figure 3.3: Price levels of rural, semi-rural and urban areas in Nepal and India, January to March 2008.

A comparison of mean values of all characteristics in Table 3.7 shows that at the given exchange rate ricebean prices in Nepal are 3.56 INR/kg higher than in India. Even though standard methods for every selected characteristic were used to quantify these, the fact that different laboratories were involved may have influenced the measurements. Thus, differences between Indian and Nepalese samples may also be due to analytical differences in the local laboratories.

The protein content of the Nepalese samples is about 6% higher than of the Indian samples and Nepalese ricebean are bigger than Indians which is indicated by the seed weight. Further, there was 4% more dirt and foreign material in Nepalese samples. All remaining characteristics are similar for both countries.

Table 3.7: Comparison of Indian and Nepalese samples (n = 153).

Characteristic	Unit	Mean Nepal	Mean India
Price	Indian Rupees (INR)/kg	26.11	22.55
Moisture	%	10.5	9.8
Protein	%	24.7	17.9
Fat	%	0.3	0.6
CrudeFibre	%	4.4	5.3
Carbohydrates	%	66.4	62.2
Ash	%	4.2	3.7
Seedweight	g/100 seeds	10.3	6.9
Foreign matter	%	8.1	4.1
L/B-Ratio	Ratio length to breadth	1.6	1.7
Water uptake ratio	Ratio of weight increase	2.0	2.1
Swelling capacity ratio	Ratio of Volume increase	1.1	1.8
Colour diversity	Herfindahl-Index	0.6	0.5

When compared to other *Vigna* species such as black gram and green gram, ricebean has a higher average ash content. Other studies of about ricebean revealed an ash content of 4.4% (Kaur & Kapoor, 1992) and the analyses for this study depicted an average ash content of 4.0% (see Annex 1). This can be contrasted with the ash content of black gram which is about 3.6% (Kaur & Kapoor, 1992) and for green gram 3.3% (USDA 2008). The fat content of ricebean is approx. 0.4%. Green gram and black gram have a higher fat content with 1.3 and 1.7% respectively (Kaur & Kapoor, 1992). The protein content of ricebean is on an average higher with 22.7% compared to green gram and black gram that both have a protein content of about 20.0%.

3.1.4 Outliers and omitted variables

Outliers, samples with extreme values, were first revealed by visual inspection of the data by using descriptive statistics and graphs. In a second step, Hebel values referred to as central leverage values where calculated. Hebel values are a measure of the impact that single observations have on the adaption of a regression function. The Hebel value is calculated by dividing the Mahalanobis-distance by n-1, where n is the number of samples. The Mahalanobis-distance measures how much a sample differs from the mean of all samples in regard to the explaining (independent) variable. Finally, 14 outliers were identified and eliminated, 6 of the Nepalese samples and 8 of Indian.

Another, requirement for the application of OLS is the avoidance of multicollinearity which occurs when two or more independent variables are correlated. SPSS offers a collinearity diagnostics while running a regression analysis. Therefore a variance inflation factor (VIF) is calculated which should not exceed the value of 10. The calculation of the VIF revealed that the characteristics carbohydrates and water uptake capacity had to be eliminated. As, water uptake capacity and swelling capacity both measure the impact of soaking it is reasonable to eliminate one of them. Carbohydrates were calculated on base of the Weender by difference. Thus, carbohydrate fraction includes all that is not moisture, fat, protein, ash and crude fibre (ASP 1994). This common way of expressing carbohydrates may have caused the multicollinearity.

3.2 Estimated coefficients of hedonic price functions

Multivariate regression which applies ordinary-least square (OLS) estimation was used to test the hypothesis that the price of ricebean can be expressed as a function of quality characteristics. The acceptance of this hypothesis indicates that a great share of the ricebean price variation can be explained through the variation of quality characteristics.

The contribution that a single independent variable provides to explain the price variation was tested with the t-values. T-values measure the possibility of a correlation between independent and dependent variable. The H0 which states that there is no relationship between dependent and independent variables can be rejected if the significances are close to zero. These variables are marked with ***, **, * for a significance at a level of $\alpha = 0.01$, 0.05 and 0.1 respectively.

The F-values indicate the relative share that explained variation has in comparison to the total observed variation. H0 which states that all coefficients of the regression are equal to zero can be rejected if the significance level of α is close to zero (≥ 0.05).

The adjusted R^2 indicates the per cent share of the price variation that could be explained through the included variables. Finally, the F-value indicates the significance of the estimation of the relation between ricebean quality and prices (Backhaus, 2000).

As functional form a double-log was chosen reflecting the non-linearity of the relationship. Also the estimated coefficient β indicates the elasticity of every characteristic. The equation is shown in F 7 where Pi is the price of a ricebean sample, α is the constant, $\beta 1$ is the coefficient of characteristic *1*, e.g. fat and *q1i* is the quantity of characteristic *1* in sample *i*. The last term μ represents the random error.

F 7: $$\ln P_i = \ln \alpha + \beta_1 \ln q_{1i} + \beta_2 \ln q_{2i} + \ldots + \beta_j \ln q_{ji} + \mu$$

The coefficients were estimated with a linear regression analysis where all characteristics were entered except the ones that were eliminated due to multicollinearity. The dependent variable price and all metric independent variables were put into natural log form.

The location of markets is reflected by the dummy variables rural, semi-urban and urban those were already discussed. The assumption behind is that ricebean is not grown in cities and thus ricebean prices/ kg rise with proximity to cities because of transportation and transaction costs. The locations were grouped into the categories due to their population density in persons/km². The base category is semi-urban.

3.2.1 Nepal

The model for Nepalese ricebean samples is shown in Table 3.8. The market status variables rural and urban confirm earlier observations that prices of ricebean in rural areas are significantly lower than in the base category semi-urban. Prices in urban areas are higher than in semi-urban areas.

Seed weight is significant at a level of $\alpha = 0.01$ and has a positive coefficient. Thus, Nepalese consumers prefer bold seeds. Fat is significantly preferred at a level of $\alpha = 0.05$ and the swelling capacity at a level of $\alpha = 0.10$. Ricebean with a high fat content and a high volume increase through soaking are liked by consumers. Further, consumers have a preference for yellow ricebean as yellow has a significant influence on the price with an $\alpha = 0.10$.

The adjusted R^2 indicates that 78% of the price variation could be explained through the characteristics that were included into the model.

Table 3.8: Estimated coefficients and interpretation for the hedonic model for Nepal (n = 108). Dependent Variable: ln_price_INR

Mean price Nepal: 26.11 INR/kg	**Unit**	**Mean value**	**Coefficients**	**T-values**
Constant			3.0899 ***	4.7018
Rural[a]	Dummy		-0.4705 ***	-11.2041
Urban[a]	Dummy		0.0849 **	2.1353
Moisture	%	10.5	-0.0269	-0.2010
Protein	%	24.7	0.1078	1.0847
Fat	%	0.3	0.1096 **	2.2659
Crude Fibre	%	4.4	-0.1802	-1.2423
Ash	%	4.2	-0.0556	-0.2893
Seed weight	g	10.3	0.1754 ***	2.5536
Foreign matter	%	8.1	-0.0141	-0.4833
L/B-Ratio	Ratio length/breadth	1.6	0.1989	1.2675
Swelling Capacity	Ratio volume increase	1.1	0.0622 *	1.5818
Black	%	2.0	-0.0043	-0.7222
Brown	%	14.0	-0.0001	-0.0185
Grey	%	10.0	-0.0035	-0.8384
Olive	%	10.0	0.0006	0.1577
Red	%	6.0	0.0004	0.0760
Yellow	%	57.0	0.0105 *	1.8721
Herfindahl-Index	Colour diversity index	0.6	-0.0356	-0.6477

R^2: 0.81
adj. R^2: 0.78
emp. F-value: 21.9***

***/**/* significant at 1; 5 or 10%, a) Base: semi-urban

3.2.2 India

All estimated coefficients for the hedonic model for India are shown in Table 3.9. The dummies for the market locations in the Indian model are not significant. Obviously, ricebean prices are varying do not differ very much between rural and urban region so far the coefficients are not significant.

Protein, crude fibre, seed weight and the colour black are significant at a level of $\alpha = 0.01$ and have a positive coefficient. Thus, Indian consumers prefer these characteristics. As pulses are a good, and cheap source of proteins it is reasonable that consumers prefer high protein contents. Proteins from pulses are cheaper than those from meat, and many consumers in India are vegetarian who are not willing to use meat as protein source. Like Nepalese consumer Indians prefer bold seeds instead of small ones. Crude fibres comprise mainly of cellulose and lignin that are fermented in the large intestine and are metabolized into e.g. short-chain fatty acids. The fibre structure of cellulose and lignin causes that crude fibre stay in the gastric for a longer time period than e.g. simple carbohydrates such as sugar. Thus, crude fibres induce a continuing feeling of saturation over a long time period (Asp, 1994).

Table 3.9: Estimated coefficients and interpretation for the hedonic model for India (n = 45). Dependent Variable: ln_price_INR

Mean price India: 22.55 INR/kg	Unit	Mean values	Coefficients	T-values
Constant			-4.9878 **	-2.2168
Rural[a]	Dummy		-0.0401	-0.3759
Urban[a]	Dummy		-0.0211	-0.1863
Moisture	%	9.8	0.5952 *	1.4567
Protein	%	17.9	1.5278 ***	3.6693
Fat	%	0.6	0.4699 *	1.8879
Crude Fibre	%	5.3	1.0379 ***	4.2628
Ash	%	3.7	-0.0117	-0.0459
Seed weight	g	6.9	0.3114 ***	2.6843
Foreign matter	%	4.1	0.0690	0.7290
L/B-Ratio	Ratio length/breadth	1.7	-0.2600	-0.4381
Swelling Capacity	Ratio volume increase	1.8	-0.1027	-0.0633
Black	%	4.0	0.0379 ***	2.7235
Brown	%	18.0	-0.0330 **	-2.1815
Grey	%	0.0	0.0245	0.5174
Olive	%	18.0	-0.0217 *	-1.6666
Red	%	3.0	-0.0084	-0.6024
Yellow	%	57.0	0.0709	0.5918
Herfindahl-Index	Colour diversity index	0.5	-0.4782 **	-2.1192

R^2: 0.80

adj. R^2: 0.66

emp. F-value: 5.634***

***/**/* significant at 1; 5 or 10%, a) Base: semi-urban

The Herfindahl-index has a negative coefficient and is significant at a level of $\alpha = 0.05$. The Herfindahl-Index ranges from 1/n to 1, whereas the maximum value of 1 indicates total concentration i.e., the sample consists only of one single colour. The negative value implies that consumers prefer colour diversity because the index gets smaller as colour diversity increases. The colour brown is disliked because it is significant at a level of $\alpha = 0.10$ and has a negative coefficient. The meaning of colours is difficult to interpret but consumers do refer from the visible colour to other cryptic characteristics which they do not like.

Fat, moisture and the colour olive are significant at a level of $\alpha = 0.10$. Fat is liked as it provides more calories per kg compared to proteins and carbohydrates. Moisture is liked in India while it has a negative coefficient Nepal. Other studies report a dislike of moisture as it indicates that the seeds are not well dried (Altemeier *et al*., 1989).

The included variables of the Indian model could explain 66% of the price variation of ricebean, which is less than the Nepalese model could explain, but this may be because the number of samples collected in India was less than half of that collected in Nepal.

3.2.3 Combining the samples from Nepal and India

The estimated coefficients of the model for Nepal and India are shown in Table 3.10. In this model for Nepal and India another dummy variable ‘country’ was introduced to differentiate between the samples of each country as these were analysed in different laboratories in each country. Thus, the data of two laboratories were combined but the dummy was inserted to allow the model to adjust for the differences. Yet, the county dummy was not significant.

In the overall model rural prices are significantly lower than semi-urban prices but the impact for urban is not significant. Crude fibre and seed weight are significantly preferred (α=0.01). Protein, fat, L/B-ratio and black are also preferred and show a positive coefficient with a significant impact on the price variation (α=0.05). Protein is preferred by consumers because pulses are a cheap source for proteins in low income countries such as India and Nepal. Other sources of protein like animal products (meat) are often costlier than pulses. An increase of the LB ratio of 1.0 indicates that a longish form is preferred by consumers because of the positive coefficient. Further, the colours olive and red are not favoured by consumers.

Table 3.10: Estimated coefficients and interpretation for the hedonic model for Nepal and India (n = 153). Dependent Variable: ln_price_INR

Mean price Nepal & India: 25.07 INR/kg	**Unit**	**Mean values**	**Coefficients**	**T-values**
Constant			0.6578	0.9517
Country	Dummy		0.0517	0.3011
Rural[a]	Dummy		-0.2952 ***	-6.2551
Urban[a]	Dummy		0.0514	1.0952
Moisture	%	10.3	0.1762	1.1340
Protein	%	22.7	0.2763 **	2.1037
Fat	%	0.4	0.1239 **	1.9407
Crude Fibre	%	4.7	0.3500 ***	2.3615
Ash	%	4.0	-0.1304	-0.9406
Seed weight	g	9.3	0.3658 ***	5.4899
Foreign matter	%	6.9	-0.0118	-0.3211
L/B-Ratio	Ratio length/breadth	1.6	0.4522 **	2.3344
Swelling Capacity	Ratio volume increase	1.3	0.0087	0.1819
Black	%	2.7	0.0133 **	2.0277
Brown	%	15.5	-0.0053	-0.9995
Grey	%	7.0	-0.0111 *	-1.9192
Olive	%	12.6	-0.0047	-1.0061
Red	%	5.2	-0.0029	-0.5000
Yellow	%	57.0	0.0074	0.9211
Herfindahl-Index	Colour diversity index	0.6	-0.0820	-1.2112

R^2: 0.65

adj. R^2: 0.60

emp. F-value: 12.8***

***/**/* significant at 1; 5 or 10%; [a] Base: semi-urban

The preference for black (α=0.05) and the dislike of grey (α=0.10) shows that these visible characteristics may reveal other cryptic ones to consumers, which have not been included in this analysis.

3.2.4 Interpretation of estimated coefficients

The hedonic price analysis allows the calculation of implicit prices of single quality characteristics because product price variations are explained by the variation of a characteristic. The implicit price of a characteristic is the price difference of two products that are completely identical except of a marginal variation of that characteristic. Thus, the implicit price is equal to the first derivative of the hedonic function (F 8, F 9) in regard to the considered characteristic

$$\textbf{F 8: } p_i = p_i\left(z_{ij}\right)$$

$$\textbf{F 9: } \frac{\delta p_i}{\delta z_i\, j} = p_j\left(z_{i,j}\right)$$

where p_j is the implicit price of characteristic j (j = 1,2,…,n) such as protein.

The regression coefficient β_j in the used double-log function (F 10) for the hedonic model represents the elasticity of the product price in regard to the considered characteristic. This coefficient indicates the product price change if the characteristic changes by 1% (Brockmeier, 1993).

$$\textbf{F 10: } \log p_i = \alpha + \sum_{j=1}^{n} \beta_j \log z_{ij}$$

The following is an interpretation of the results in the hedonic model for India and Nepal as shown in Table 3.10. The table also includes the average prices per kg ricebean and average values of metric characteristics. All interpretations are made under *ceteris paribus* condition which assumes that if one variable is changed all remaining variables remain constant.

For instance, protein is positively related to price; if protein is increased by one per cent, i.e. from the mean of 22.7% to 22.9% then the price would increase by 0.3%. The mean price in Nepal and India is 25.07 INR/kg and would rise to 25.15 INR/kg by adding 0.3%. A 1 % increase of crude fibre would increase the price by 0.4%. If the weight would be increase by 1% then the price raises by 0.4%. If the form of ricebean would be more longish by increasing the L/B ratio by 1% than the price would increase by 0.5%. The mean value of fat content in ricebean is 0.4% and the fat coefficient with a value of 0.1 is little. Thus, fat is preferred but an increase has only a little impact on the price. The coefficients of black and grey are even smaller than the coefficient of fat. Grey is negatively related to the price, i.e. decreasing the share of grey ricebean would increase the price.

4 Conclusion and discussion

The adequacy of a commodity for a particular use depends on its quality that is defined by quality characteristics. The perception and preferences of consumers influences which characteristics define the product quality. Only characteristics that are relevant for consumers influence their purchase decisions. Therefore, additionally to farmers' needs, breeding should consider consumers' perceptions of product quality. Breeding without having consumer's needs in mind can lead to crop varieties which help neither farmers nor consumers. Where farmers cultivate an improved crop with high yields and better pest resistant, this is only beneficial if that crop can be sold to generate income. In the worst case scenario, even the farmer himself is not interested in consuming the agronomically superior crop. There has to be a balance between agronomic improvements and the preferences of consumers.

Additionally, ricebean is very heterogeneous. Ricebean varieties differ in size, colour and nutritional components such as protein content. In view of the large variation in quality, it is important to determine those characteristics that are relevant for consumers, in order to identify the right ricebean varieties for breeding.

The objective here was to provide breeders an instrument to evaluate ricebean varieties with respect to quality characteristics that are relevant to consumers. For that purpose, we had to determine if there are characteristics of ricebean which are liked or disliked by consumers in India and Nepal. The determined characteristics could then guide the work of breeders. The instrument that was chosen to assess consumers' preferences was the hedonic price analysis, based upon Lancaster's "New approach to consumer theory". The central idea is that goods are valued by consumers for their utility deriving characteristics. Hence, consumers are not evaluating the good itself but the characteristics of goods. The demand for a special characteristic is revealed through the demand for a product that contains the considered characteristic. If the amount of the demanded characteristic changes, the product price changes too. Thus, the hedonic price analysis evaluates products on basis of their heterogeneity. Thereby, it is possible to calculate implicit prices of characteristics which correspond to the price difference of two products that are identical except the considered characteristic.

Further, the hedonic price analysis was chosen because it is based on revealed preferences. Preferences are revealed because market prices reflect how much consumers in India and Nepal are willing to pay for the different ricebean varieties. Additionally, the hedonic analysis allows use of both cryptic and evident characteristics. Cryptic characteristics, such as protein content or swelling capacity, could not be evaluated by consumers while purchasing ricebean but these characteristics also influence the perceived quality. Evident characteristics such as colour and size are visible. Both characteristic types influence the perceived quality of a product. Thus, the hedonic price analysis could be used to improve the quality and thereby may increase the probability that the improved ricebean variety is accepted by consumers.

In 2008, 153 ricebean samples were analysed for cryptic and evident characteristics in laboratories. The applicability of the hedonic price analysis was confirmed as 60% of the price variation of ricebean samples in India and Nepal could be explained through the characteristics that were included. Four quality characteristics i.e. content of protein, crude fibre and fat and seed size were identified to be significantly related to ricebean price.

Although not a breeder's problem, consumers clearly do not like foreign material in their ricebean purchases. Farmers or traders could solve this problem by cleaning the ricebean prior to selling, as there is clearly a willingness to pay for cleaner ricebean lots. With these elasticities breeders can assess the expected price of an improved ricebean variety at an early stage, as quantities of 100 to 200 grams are sufficient to calculate the consumer preferences.

In conclusion, the hedonic price analysis shows that there are certain quality characteristics of ricebean which can be objectively measured and which explain consumers' preferences. Future prospects must combine farmers and consumers requirements. Combining the results of the assessed quality characteristics with higher yield would probably lead to a rapidly adopted ricebean variety due to increased yield and higher prices for better quality, so enabling farmers to sell more ricebean and so generate income. This will be facilitated by the next stage of the work, to produce a Consumer Preference Index (Buergeldt *et al*., 2010)

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