CHANNELING CONSUMPTION PREFERENCES FOR CO-EXISTENCE OF LANDRACE AND MODERN VARIETIES *IN-SITU*

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ABSTRACT: The study examines the least-cost option of conserving landraces *in-situ* by the development of market friction instruments. The empirical examination is comprised of two closely-related studies on eggplant production and consumption sectors of India. An examination of the cost and return structure of eggplant farming in the study area reveals that the incremental farm price of eggplant products of landrace origin eclipses the yield advantage of hybrid varieties. Possibly due to the information asymmetries and other imperfections existing in this market, the price increment currently realized by the eggplant farmers is still only a fraction of consumers' willingness to pay for landraces. This wide margin is indicative of the unexploited potential of labelling and certification schemes as an emerging agrobiodiversity conservation strategy.

KEY WORDS: Agrobiodiversity; Contingent valuation; Eggplant; Hedonic pricing; India; Labelling and certification; Landrace conservation

I. INTRODUCTION

This paper examines the potentials of market-based instruments in conserving landrace varieties *in-situ*, when they compete for acreage with higher yielding modern varieties (MVs). In areas where landraces are better adapted to the local agro-climatic conditions over MVs, cultivating them would entail relatively lower per-unit cost (Smale *et al.*, 2004), and would result in their *de facto* conservation by farmers. Even in the absence of such natural incentives, market segmentation for landrace products with a significant price increment can facilitate a similar conservation strategy. Markets for such *green* goods and services and eco-certification programmes are increasingly popular nowadays, owing largely to the economic growth that presents favourable conditions (Hamilton and Zilberman, 2006). While there has been recent efforts to better understand the incentives for management of on-farm crop diversity by addressing farmers' perceptions and choices regarding morphological traits (e.g., Van Dusen and Taylor, 2005; Birol *et al*., 2006; Birol and Rayn-Villalba, 2009), the literature tends to neglect the crucial role of non-farmer buyer preferences in developing countries, especially in the informal market chains. Bridging this knowledge gap would help to design and support incipient ‘Market Friction Reducing Instruments’ (MFRIs), linked to local food markets, that in turn may provide farmers, the right incentives for *in-situ* conservation of landraces.

Conventionally, the potential to fully exploit niche markets for green products has often been considered as limited to the wealthy nations (Grote, 2002; Basu *et al.*, 2003). Against this widespread perception, we reassess the potential demand for landrace products in the developing economy of India. The eggplant production and consumption sectors are taken for illustration. At present, food product differentiation in India mainly occurs without formal certification and labelling schemes. However, in few crops (like eggplant), there exist distinguishable phenotypical characteristics indicative of landrace origin. In such cases, the otherwise credence and/or experience attribute of landrace origin turns to search attribute for the consumers. Thus, an examination of the market price structure of these crops is expected to reveal the potential of a more formal and wider provision of information (with labelling and certification schemes) on landrace origin on their on-farm conservation.

The rationale behind selecting eggplant production system in India is elaborated in the next section, while section III describes the primary data sets used in the empirical analysis. Results of the primary data analysis are provided and discussed in section IV. Here, the case of eggplant in India is illustrated as two different sub-studies. The first deals with the supply side (farmer households) to estimate the market value currently obtained for the landrace attribute, while the second addresses the demand side (consumer households) to estimate the full consumption value of landraces. The last section concludes and addresses the main policy implications.

II. THE CONTEXT

India has made significant progress in recent years towards setting up a legal regime for the management of its plant genetic resources (Biber-Klemm *et al.*, 2005). At the same time, agricultural development policies are increasingly focused on the development and dissemination of high yielding MVs having limited genetic diversity. This situation exemplifies the agricultural development *versus* resource conservation political dichotomy or clash of interests. This is explicit in the case of eggplant crop, for which India is the second largest producer in the world (FAOSTAT, 2006). Traditionally, farmers have maintained and supplied the eggplant seeds, resulting in special varieties adapted to the region’s environment as well as local consumers’ tastes. Notwithstanding the array of different values associated with eggplant landraces, we focus on the narrower, but significant, consumptive value. It is not surprising to find that consumer preference for eggplant fruits are expressed according to the characteristics such as taste, colour, size, spiny-calyx, shape etc. Such preferences become complex to analyze due to the large combination of the fruit's characteristics that in turn has historically led to the cultivation of eggplant varieties with very diverse phenotypes. Further, in the face of such diversity, there also has been a significant adoption of eggplant hybrids in the country. Since the 1980s, an increasing number of the F_1 eggplant hybrid varieties bred by private seed companies are being commercialized. More specifically, hybrids are being widely cultivated in the southern states of Karnataka, Andhra Pradesh, and Maharashtra. By contrast, in eastern parts of India (especially the states of West Bengal and Orissa, which together account for around 50% of the total eggplant area in the country) the adoption of hybrids is marginal, probably because the landraces are more adapted to the local soil and climatic conditions (Krishna and Qaim, 2007).

Apart from the conventional breeding sector, modern biotechnology poses new challenges to on-farm landrace conservation, alongside providing opportunities to realize high levels of yield and reduced level of insecticide use. Recognizing the economic relevance of resistant breeds in eggplant, GM hybrids and open pollinated varieties are currently developed under a unique public-private sector research collaboration in India (Krishna and Qaim, 2007; 2008b). Adoption of high yielding varieties like GM eggplant is often perceived both to foster agricultural development. Nevertheless, critics call attention to the displacement of on-farm genetic diversity and transgenic escape (due to natural out-crossing) as amongst the potential environmental threats associated with GM crops (Ervin *et al*. 2001). Although some studies recently indicated *ex ante* that the Indian consumers have indicated a general positive attitude towards GM foods (Anand *et al*., 2007; Krishna and Qaim, 2008a), there is a possibility that once the GM eggplant comes to be marketed in India, the consumers' knowledge and perception may alter significantly through increased media coverage, which need not always be objective or scientific. The present study gains more significance in this background by providing an insight into the potential welfare changes that the consumer perception towards a production technology brings forth. It is also expected that the conventional hybrids and GM varieties will have a positive impact on farm productivity even though they may be less favoured from the consumers' perspective.

III. THE DATA

Data on eggplant cultivation in India were collected from a cross section of 240 farm households from Andhra Pradesh and Karnataka, two leading eggplant producing states in South India in 2005. The survey covered the major eggplant-growing tracts within the selected states, most of which are located in the river belts. Using a stratified random sample, six districts and 13 *taluks* (revenue subdivisions within each district) were selected purposively based on the area under eggplant cultivation. Villages and farm households were selected randomly. Of the sampled households 36% cultivate eggplant local varieties (LVs), implying an adoption rate of MV technology of 64% in the study area.[1] Farm economic data was gathered from these households, which included yields, variable production costs and farm prices for eggplant fruits. Information about the attributes of the marketed eggplant fruits were also gathered from each farmer, including the skin colour, presence of spines in fruit calyx etc. Such information is complemented with the available data on socio-economic characteristics of the farm household through structured surveys.

In addition, data from vegetable consumers was also collected during 2006 from five important urban locations in India: New Delhi, Bangalore, Kolkata, Kolar, and Barddhaman. The first three are among the largest cities of India and administrated by municipal corporations. Kolar and Barddhaman are two district headquarters in the states Karnataka and West Bengal respectively, which are in close proximity to important eggplant production regions. The stratified random sample design was followed for data collection. Each location is first divided into zones and corporation wards and consumer households were selected randomly from each of these urban zones. In total, the sample consisted of 645 households from 61 corporation wards and this study employs a subset of 629 observations avoiding households reporting zero consumption of eggplant fruits. No significant difference in socio-economic characteristics was observed between the consumer and non-consumer households.

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[1] The term 'local variety' (LV) includes the open pollinated eggplant population raised from either farm saved or purchased seeds/seedlings available. Farmers consider all of them as indigenous varieties or landraces cultivated in the locality for years and the product is sold in the market under the title of landraces. However, we have also found few cases where the seed lot is actually farm-saved seeds of improved varieties cultivated by other farmers of the locality. It was not feasible to locate the exact pedigree due to resource constraints and hence the wider term LV instead of landraces is used instead in the supply side empirical analysis.

The survey was designed to gather information about consumers' preferences and attitudes towards different eggplant characteristics, including those of landrace fruits. In a second stage, for those individuals who indicated a clear preference for landraces over hybrids, a dichotomous choice question on their willingness to purchase landrace products was posed against hypothetical price increments, in order to estimate the consumption use value of eggplant landraces.

IV. RESULTS AND DISCUSSION

IV.1. SUPPLY AND PRICE ANALYSIS

This sub-section includes two complementary studies. One deals with testing whether hybrid varieties of eggplants in India are more productive than local varieties given the inputs used in their cultivation. The other addresses the question of whether and to what extent there is an output price difference between local and hybrid eggplants.

Productivity of local vs. hybrid varieties of eggplants

An examination of basic information regarding the economics of eggplant (local varieties/LVs *versus* hybrids/MVs) cultivation in South India shows no significant difference in the total variable cost of cultivation of LVs against hybrids/MVs, as against the conventional wisdom that the per-acre variable cost of LV cultivation is lower.[2] Unsurprisingly, eggplant hybrids show a marked superiority over LVs with respect to yield. The average marketed yield is 95 versus 112 quintals (Q) per acre for LVs and MVs respectively. (The marketable yield is not very different in both cases as farm households' consumption of eggplant is negligible). Owing to this yield superiority, the per-unit cost of hybrid cultivation is lower by about 29%. Also, at uniform output prices, hybrid eggplants generate significantly higher net returns to farmers.

Further, a Cobb-Douglas production function with marketable yield of eggplant as dependent variable is estimated. To avoid any endogeneity bias, both pesticide application and hybrid

[2] However, the cost structure varies. The main difference in the cost structure of hybrids and LVs in the study area is that the latter is mostly cultivated in the leased-in land and is therefore associated with a higher rent. In the case of hybrid production, however, the cost of material inputs (especially chemical fertilizers) is comparatively high.

adoption are instrumented, with district level average pesticide price and information variables respectively. These IVs were proved significant in the input-use and adoption models, but do not influence the per-acre yields, indicating that the production function is properly identified. The estimation is carried out by estimating the production function with and without the interaction terms between the hybrid adoption (IV) and other input variables. Results are shown in Table 1.

In the first specification, the coefficient of hybrid adoption is positive but insignificant, indicating that MV technology does not increase eggplant yield when controlling for other factors. However, inclusion of the interaction terms, which indicates whether or not the MV technology changes the production elasticity of other inputs, drastically changes the coefficients. In Model II, the MV adoption dummy is significant and positive, whereas its interaction term with human labour is largely negative. It suggests that hybrid eggplant is less responsive to labour input than its LVs. As there is no significant difference between hybrid and LV production with respect to mean labour employed, the negative coefficient is somewhat surprising. Similar low labour responsiveness of hybrid technology is reported by Ramasamy *et al*. (2003) in case of rice cultivation of South India. Furthermore, taking the case of hybrid wheat in Centre India, Matuschke *et al*. (2007) found no impact of hybrid seed adoption on productivity of human labour. These evidences may suggest better adaptability of hybrids in labour-scarce situations.

The interaction terms with fertilizer and plant protection chemicals are insignificant. Hybrid cultivation is fertilizer-intensive with 4.98 Q/acre against the rate of 3.95 Q/acre for the LVs. In other words, hybrids allow higher application of chemical fertilizers and reap the associated yield benefits. Also noteworthy is the fact that hybrid adopters are better educated compared to the non-adopters, and education is a productivity-enhancing factor. In sum, hybrids and LVs are equally productive at the corresponding mean level of inputs, which suggests that the higher average yield associated with eggplant hybrids is due to the higher fertilizer use and education status of technology adopters, rather than any heterosis effect.

Implicit prices of local vs. hybrid varieties of eggplants

Farm price obtained by the LV cultivators (Rs. 501/Q) is around 31% higher in comparison to that associated with hybrids (Rs. 383/Q). This higher price of LVs compensates for their productivity disadvantage relative to hybrids. Thus, there is no significant difference in net marginal revenue between hybrids and LVs. However, the significant question is, whether the price differential is due to the LV status itself or due to the associated product characteristics, which is tested by means of a hedonic price function.

For estimation purposes, we adopt the Box-Cox transformation function and the marginal implicit prices (MIP) are computed (Table 2). Six farm household characteristics (viz. years of experience of head of the household in eggplant farming, mass media exposure and contact with the government extension agencies, formal education status of household head, time taken to reach market with produce, and size of farm owned) are included in the model. The price function estimation is carried out in two steps: first including only the product, regional, and seasonal factors alone and later adding the household characteristics to the model as it is unconventional to include the latter in hedonic pricing estimation.

The analysis, without the inclusion of household characteristics, reveals that the LV status is associated with a MIP of Rs.65/Q, which is 55% of the current absolute price difference between LV and MV. The share of fruits affected with fruit borer pest drastically reduces the market price, which confirms the findings by Amegbeto *et al.* (2008) regarding impact of pest infestation on fruit market price. Other fruit characteristics viz. green/white skin colour and presence of spines in the calyx also increases the market price.[3] All in all, the aggregate negative impact of hybrid status and fruit colour may be largely determining the price difference observed.

Farmer attributes are also included in the model estimation in order to account for the impact of farmers' bargaining skills on product price obtained. When the household characteristics are included in the model, the MIP associated with LV status on market price marginally increases to Rs.69/Q, whereas that of borer infestation and spiny calyx reduces. In addition, farmers who consider mass media as a major source of farm information are able to obtain higher price (by about 10%). Experience in eggplant farming is also found to be positively affecting the farm price, possibly due to the fact that farming experience provides better information on the complex eggplant marketing system and associated price structure, eventually influencing

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[3] Regarding the spiny calyx attribute, 34% of hybrids against 6% of LVs possess spines on the calyx but surprisingly, consumers commonly associate the spiny attribute with landrace status. Adverse selection due to this information asymmetry may be one of the reasons for the associated high marginal implicit price of spiny calyx and hence can be interpreted as 'disguise' benefits (cf. Hamilton and Zilberman, 2006) to MV farmers, due to the absence of effective product differentiation.

farmers' bargaining power. Surprisingly, no such positive and significant effect is found associated with formal education. Farmers owning larger farms obtained lower market price for their products, owing probably to the selection of buyers. Small farmers sell their products mostly directly to the consumers, whereas procurement by the wholesale agents is common for the larger quantities.

There also exists high seasonal and regional variation in eggplant prices. Farmers obtain a lower price during the summer and Rabi seasons in comparison to the Kharif season. The lowest price obtained is in summer season, during which only 29% of LVs and 15% of MVs are cultivated. The better adaptability of LVs to drought may be a factor attributing to this varietal choice, even at a price disadvantage. Similar inter-seasonal variation of perishable products is observed by Parker and Zilberman (1993) and Amegbeto *et al*. (2008). There is also variation in market price across production locations. For instance, in Karnataka, where the productivity of eggplant is comparatively high, farmers obtain a lower price compared to those of the nearby state Andhra Pradesh.

All in all, these results indicate that the LV attribute *per se* provides a significantly higher price for the cultivators, and that the product market is differentiated to a certain degree for catering the needs of consumers. Even at the limited information provision in the absence of formal labels and certification schemes, the price difference of Rs. 69/Q owing solely to the LV status is significantly high and enough to cover its disadvantage of high per-unit cost of production (Rs. 45/Q). Hence, we cannot reject the hypothesis that the price premium currently realized in the informal markets for the LV attribute compensates for its lower productivity relative to its hybrid counterpart.

Information asymmetries and market imperfections exist in the current scenario of no labels for local variety products. The transaction costs involved in keeping the eggplant market segmented for LVs would rise with the number of market agents involved. This may create a drift in the supply function and thus transfer only a fraction of consumers' WTP to the hands of the farmers. In addition, there is a share of consumers who are not able to differentiate between LVs and hybrids, implying that albeit the higher price for eggplant landraces, the scenario may not wholly reflect consumers' preferences. The next section deals with ascertaining consumers' preferences for the landrace products by directly eliciting their WTP for the landrace attribute. We use information about consumers in urban centres in India for this purpose.

IV.2. CONSUMERS' STATED WTP FOR LANDRACE ATTRIBUTE

In the consumer survey, the majority of respondents (79%) stated that they could identify eggplant landrace (vegetables) as being different from their hybrid counterparts. When presented a uniform price scenario, 74% of all sampled consumers preferred landrace eggplant fruits over that of MVs, whereas only 13% showed a preference for the latter and the rest being indifferent between landrace and hybrid products. Preference for landraces is stronger in Kolkata and Barddhaman, the cities surrounded by landrace growing tracts. The relatively large preference for hybrid eggplants occur mostly in New Delhi and Bangalore, which are located either far away from the production locations or are surrounded by hybrid eggplant growing farm lands.

Preference for landrace products may arise due to experience and credence qualities. The first category includes better taste (54% of sampled respondents cited it as one of the reasons for preference), cooking quality (15%), and desirable texture (10%). Credence attributes include high nutrition value (mentioned by 25% of respondents), reduced level of agro-chemical residues (23%), and innate medicinal properties (16%). About 60% of respondents mentioned at least one of the experience attributes as reason for preferring landrace products, whereas 47% indicated at least single credence attribute.

Alongside understanding the consumer preferences towards landraces, it is also necessary to study how these preferences are translated into willingness to purchase landrace products under different prices. The estimation results of the bivariate (preference/purchase) probit model are shown in Table 3. The preference model suggests that younger consumers have a more positive attitude towards landraces. Similarly, per capita income is found to raise the preference for landraces (albeit at a decreasing rate). Further, consumers who describe themselves capable of distinguishing landrace eggplants show a positive attitude to them. This is linked with the fact that consumers from East India (that is from Kolkata and Burddhaman), where landraces are extensively grown, are more favourable towards its consumption.

The purchase model assesses the strength of the attitudes toward landraces using a stated preference valuation method. It addresses the hypothetical purchase decisions (willingness to purchase) by those consumers who indicate a positive preference towards landrace products. The estimation results of this model appear in the right column of Table 3. Interestingly, older people are associated with a higher probability of purchasing landraces at a given price. Income and education also significantly enhances the probability that the consumer with a positive attitude towards landraces would be willing to pay a price premium for the landrace eggplant. This result comes in tune with that of other valuation studies on organic products (e.g., Florax *et al*., 2005). Similar is the impact of information, which is represented here by both the education status and the ability to identify the landrace products in the market. In stark contrast to the preference model, consumers of West Bengal showed lowest WTP amongst the favourable households from other parts of India. This paradox may be due to the fact that consumers face no felt need for differential markets in these regions, as the existing local vegetable markets supply mostly the landrace products.

Interestingly, consumers' ability to differentiate landrace products from that of hybrids is associated positively not only with preference for landraces, but with their willingness to purchase at a given price premium also. The marginal impact of information on probability of purchase is 15%. This positive association between information and consumers' WTP is indicative of the fact there is potential for future market development for landrace outputs, upon provision of reliable information through labelling and certification. This result accentuates the necessity of simultaneous emergence of the two types of friction reduction instruments – both market development and information programmes, as suggested by Stavins (2003) – in order to effectively translate consumer preferences to farmers' decision making. It also supports the idea that the availability of information can foster the development of green markets as in the case of eco-labelled products in developed countries (IFAV, 2001).

The median WTP is estimated as Rs.6.00/kg for the consumer households favouring landrace products, and as Rs. 4.50/ kg for all households. These price premium values respectively are 57% and 43% of the eggplant price in the urban consumer market during the time of data collection, indicating a significant potential for developing segmented markets for the landrace attribute. This can be confronted with the information from the supply analysis. The current informal markets provide farmers a price premium of 31% (Rs.1.18/kg), while the price increment attributed specifically for the landrace attribute is only 16% (Re.0.69/kg). On the other hand, about 50% of urban consumers are willing to pay up to Rs. 4.50/kg for the same landrace product. Thus, the potential consumer premium is more than six times greater than the price premium currently realized by farmers, which indicates the scope for a more organized market system with labels and certificates to conserve landraces *in situ*. However, it would be unrealistic to assume that the consumer WTP could be translated entirely to the farmer, free of transaction costs. Furthermore, following Parker and Zilberman (1993), the marketing margin is expected to increase with the level of quality characteristics. Having said this, if the MFRIs can generate a farm-price premium at least at half of the median WTP value, they could result in a significant increase in farm profits, thus creating incentives for farmers to increase the supply of landrace products.

These results suggest that the evolution of reliable marketing channels alongside a formal labelling system for landrace products could help increase their acreage. It is quite plausible that consumptive values for landraces by urban consumers exist for other major agricultural products also. Imparting market information on product origin to consumers could help conserve landrace resources in these crops, provided the price premium hence generated is greater than the transaction cost of information provision.

V. CONCLUSIONS

This paper has aimed at contributing to the empirical literature on the analysis of novel market (friction reducing) instruments that can be applied to achieve the goal of *in-situ* landrace conservation in developing countries. The conditions of market segregation for the *in-situ* co-existence of landraces and modern varieties have been discussed and the importance of information dissemination under a potential labelling or certification system for landraces addressed. The argument has been illustrated with a congenial case of eggplants in south India where the conventional hybrid technology diffusion and its associated yield impact is large.

Currently, it is observed that the higher implicit price associated with the traditional eggplant variety attribute (without any formal labelling system) is able to compensate the yield advantage of hybrid eggplant seeds from the farmers' perspective. However, we also identify that there exists an ever greater consumptive use-value and demand for various eggplant landrace attributes. An analysis of urban consumers' preferences towards landrace eggplants suggests that the price premium currently realized by landrace cultivators is only a small fraction of what consumers would be willing to pay for the landrace attribute. By not fully translating consumers' preferences to farmers, the current market system jeopardises the landrace conservation. The market imperfection may be ameliorated by using reliable information provision schemes by means of labels and certificates denoting landrace origin of the eggplant produce. Of course, the now higher price premium associated with the labelling scheme would need to cover the transaction costs that would now be created. However, a wide margin exists between consumers' WTP and the price increment currently realized for landrace products. This indicates that even under some additional transaction costs such labelling programmes may well work.

Two broad policy issues are worth mentioning with respect to the findings of this paper. First, the hybrid technology diffusion can be seen only as a partial success since the perception about the quality of the resultant products is inferior from the consumers' perspective. We thus reinstate the importance of taking into account the consumption priorities in developing agricultural technologies. Equally important here is the dissemination of unbiased information about the technology attributes in society. Secondly, there appears to be a significant scope for developing a formal marketing system with labelling and certification to differentiate products of landrace origin in developing economies such as India with a large urban population base. The design of low cost marketing channels having potential to transfer urban consumers' consumptive value back to the cultivators could help them sustain the supply of green products. In case of landraces, it would contribute to the conservation of agrobiodiversity *in-situ*.

REFERENCES

Amegbeto, N.K., V.M. Manyong, O. Coulibaly and R. Asiedu (2008), 'Estimating market demand for fresh yam characteristics using contingent valuation: implications for crop breeding and production choices', *Agricultural Economics* **39**: 349-363.

Anand, A., R.C. Mittelhammer and J.J. McCluskey (2007), 'Consumer response to information and second generation genetically modified food in India', *Journal of Agricultural and Food Industrial Organization* 5(8).

Basu, A.K., N.H. Chau and U. Grote (2003), 'Eco-labeling and stages of development', *Review of Development Economics* **7**(2): 228-47.

Biber-Klemm, S., T. Cottier, P. Cullet, and D.S. Berglas (2005), 'The current law of plant genetic resources and traditional knowledge', in Biber-Klemm, S., T. Cottier, and D.S. Berglas (eds.), *Rights to plant genetic resources and traditional knowledge*, Oxfordshire: CAB International, pp. 56-111.

Birol, E., M. Smale and A. Gyovai (2006), 'Using a choice experiment to estimate farmers' valuation of agricultural biodiversity on Hungarian small farms', *Environmental and Resource Economics* **34**(4): 439–69.

Birol, E. and E. Rayn-Villalba (2009), 'Estimating Mexican farmers' valuation of *Milpa* diversity and genetically modified maize: a choice experiment approach', in: Kontoleon, A., U. Pascual, and M. Smale, (eds.), *Agricultural biodiversity for Economic Development* Routledge.

Ervin, D., S. Batie, R. Welsh, C. L Carpentier, J. I. Fern, N. J. Richman and M.A. Schulz (2001), 'Transgenic crops: An environmental assessment', Policy Studies Report No. 15, Henry A. Wallace Center for Agricultural and Environmental Policy, Arlington, VA.

FAOSTAT (2006) Available at www.faostat.fao.org (Accessed on September 2006).

Florax, R.J.G.M., C. M. Travisi and P. Nijkamp (2005), ‘A meta-analysis of the willingness to pay for reductions in pesticide risk exposure’, *European Review of Agricultural Economics* **32**(4):441-467.

Grote, U. (2002), ‘Eco-labelling in the agricultural sector: an international perspective’, Proceedings of the High-Level Pan European Conference on Agriculture and Biodiversity, European Council, Strasbourg.

Hamilton, S.F. and D. Zilberman (2006), ‘Green markets, eco-certification, and equilibrium fraud’, *Journal of Environmental Economics and Management* **52**(3): 627-44.

IFAV (2001), *Recherche: Verbraucherverhalten beim Lebensmittelkauf*. Institut für Angewandte Verbraucherforschung e.V. (IFAV), Köln.

Krishna, V.V. and M. Qaim (2007), ‘Estimating the adoption of Bt eggplant in India: Who benefits from public-private partnership?’, *Food Policy* **32**(5/6): 523-43.

------------------------------------ (2008a), ‘Consumer attitudes towards GM food and pesticide residues in India’, *Review of Agricultural Economics* **30**(2): 233-51.

------------------------------------ (2008b), ‘Potential impacts of Bt eggplant on economic surplus and farmers’ health in India’, *Agricultural Economics* **38**(2): 167-80.

Matuschke, I., R.R. Mishra and M. Qaim (2007), ‘Adoption and impact of hybrid wheat in India’, *World Development* **35**(8): 1422-1435.

Parker, D.D. and D. Zilberman (1993), ‘Hedonic estimation of quality factors affecting the farm-retail margin’, *American Journal of Agricultural Economics* **75**: 458-466.

Ramasamy, C., A. Janaiah, K.N. Selvaraj and M. Hossain (2003), ‘Hybrid rice in Tamil Nadu: evaluation of farmers’ experience’, *Economic and Political Weekly* **38**(25):2509-12.

Smale, M., M.R. Bellon, D. Jarvis and B. Sthapit (2004), ‘Economic concepts for designing policies to conserve crop genetic resources on farms’, *Genetic Resource and Crop Evolution* **51**(2): 121-35.

Stavins, R.N. (2003), ‘Experience with market-based environmental policy instruments’, In Mäler, K.G. and J.R. Vincent (eds), *Handbook of Environmental Economics*, Elsevier B.V. **9**(1): 355-435.

Van Dusen, M. E. and J.E. Taylor (2005), ‘Missing markets and crop diversity: evidence from Mexico’, *Environment and Development Economics* **10**(4): 513-31.

Table 1. Production function estimates of eggplant cultivation in South India (N = 240)

Variable	Description	Model I			Model II		
		Coef.	SE	p-value	Coef.	SE	p-value
Fertilizer	Logarithm of fertilizer amount in kg/acre	0.222	0.120	0.07	0.255	0.233	0.28
Labor	Logarithm of human labour days per acre	0.266	0.116	0.02	0.951	0.268	0.00
PPC	Logarithm of cost of plant protection chemicals per acre*	0.112	0.288	0.70	-0.399	0.719	0.58
Hybrid eggplant	Adoption dummy*	0.139	0.399	0.73	5.526	2.129	0.01
Experience	Farmer's experience in eggplant cultivation in years	0.003	0.006	0.63	0.003	0.006	0.64
Education	Schooling obtained by farmer in years	0.035	0.010	0.00	0.032	0.010	0.00
Rabi	Season dummy (vs. Kharif)	0.301	0.145	0.04	0.229	0.147	0.12
Summer	Season dummy (vs. Kharif)	0.349	0.164	0.03	0.310	0.162	0.06
Andhra Pradesh	State dummy (vs. Karnataka)	-0.106	0.273	0.70	-0.107	0.276	0.70
Hybrid-Fertilizer	Interaction term				-0.047	0.310	0.88
Hybrid-Labor	Interaction term				-1.089	0.363	0.00
Hybrid-PPC	Interaction term				0.664	0.908	0.47
Model intercept		1.098	0.784	0.16	-2.145	1.492	0.15
Model statistics	F	5.25			4.96		
	Prob > F	0.00			0.00		
	Adjusted R^2	0.138			0.166		

Notes: Dependent variable in both models is logarithm of marketable yield of eggplant (Q/acre).
* Instrumented variables

Table 2. Hedonic price function (N = 239)

Variables	Description	Model I				Model II			
		Coef.	SE	p-value	MIP	Coef.	SE	p-value	MIP
Experience	Farmer's experience in eggplant cultivation in years					0.021	4.43	0.04	2.24
Transportation	Time to transport the produce to market in hours					-0.043	1.64	0.20	-4.58
Extension	Information dummy					-0.008	0.00	0.97	-0.83
Mass media	Information dummy					0.382	3.04	0.08	41.08
Education	Schooling obtained by farmer in years					0.002	0.02	0.90	0.26
Farm size	Farm size owned by the household in acres					-0.036	4.09	0.04	-3.84
Hybrid eggplant	Adoption dummy (vs. LVs)	-0.583	4.73	0.03	-65.01	-0.644	6.16	0.01	-69.31
Infestation	Share of pest infested fruits in the marketed lot (0-1)	-3.322	10.41	0.00	-370.53	-3.072	9.55	0.00	-330.55
Purple fruit	Fruit skin dummy (vs. green/white)	-0.493	3.96	0.05	-55.03	-0.501	4.38	0.04	-53.94
Spiny calyx	Dummy for spines in the fruit calyx	0.724	10.20	0.00	80.73	0.649	8.50	0.00	69.80
Rabi	Season dummy (vs. Kharif)	-0.498	5.95	0.02	-55.58	-0.561	7.45	0.01	-60.40
Summer	Season dummy (vs. Kharif)	-0.809	10.26	0.00	-90.30	-0.871	12.10	0.00	-93.70
Andhra Pradesh	State dummy (vs. Karnataka)	0.787	9.60	0.00	87.83	0.356	1.45	0.23	38.33
Model intercept		13.221				13.230			
θ		0.223	0.117	0.06		0.217	0.116	0.06	
Model statistics	Log likelihood		-1508.45				-1503.46		
	LR χ^2		72.20				84.19		
	p-value		0.00				0.00		

Notes: Dependent variable in both models is farm price of eggplant (Rs/Q); MIP stands for marginal implicit price or partial derivative of the corresponding variable.

Table 3. Partial observability bivariate probit estimates on eggplant consumer preference for and willingness to purchase landrace products (N = 629)

Variable	Description	Preference			Purchase		
		Coef.	Robust SE	p-value	Coef.	Robust SE	p-value
Female	Sex dummy	-0.265	0.293	0.37	-0.223	0.256	0.38
Age	Age of respondent in years	-0.137	0.063	0.03	0.084	0.033	0.01
Square of Age		0.002	0.001	0.01	-0.001	3.E-04	0.00
Education	Years of schooling obtained by respondent	0.010	0.022	0.65	0.034	0.021	0.10
Identification	Dummy for respondent's ability to identify the landrace products	0.575	0.308	0.06	0.417	0.242	0.08
Occupation	Dummy for respondent's involvement in an income generating occupation	-0.210	0.291	0.47	-0.243	0.233	0.30
Household	Number of members in the household	0.009	0.053	0.87	0.067	0.056	0.23
PCAI	Annual per capita income of the household (thousand Rs)	0.040	0.023	0.09	0.052	0.021	0.01
Square of PCAI		-3.E-04	2.E-04	0.12	-3.E-04	1.E-04	0.08
East India	Dummy for respondent from Kolkata and Burddhaman	6.757	0.624	0.00	-1.319	0.680	0.05
South India	Dummy for respondent from Bangalore and Kolar	0.337	0.433	0.44	-0.389	0.641	0.54
Bid	Bid quoted in willingness to purchase question (Rs/kg)				-0.336	0.040	0.00
Model intercept		1.614	1.918	0.40	-1.592	0.545	0.00
Model statistics	ρ	-0.647					
	Log likelihood	-329.07					
	Wald chi2(23)	1510.06					