Journal of Ecological Anthropology

Volume 9
Issue 1 *Volume 9, Issue 1 (2005)*

Article 2

2005

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Abstract

The Brahmaputra is the largest river system in northeast India. Its valley, in the State of Assam, is home to the Assamese people, indigenous Mishing and Karbi tribes, and Kaziranga National Park. A spectacular array of wildlife shares the floodplain including the endangered Asian elephant, tiger, one-horned rhinoceros and wild buffalo. The fertile floodplain and tea estates have attracted immigrants from within India and from neighboring countries. Migration has been linked to Assam's high population density and agriculture expansion. Based on household surveys in 37 villages in the park's periphery, we compared home garden productivity and economic return among residents and immigrants of different ethnic groups and explored the hypothesis that residents had an advantage over immigrants in maximizing gains from home gardens resources. The results indicated that, although resident home gardens were larger, production from immigrant home gardens was over four times higher and their economic returns were greater. Immigrants, who tended to live in low-lying areas close to the park and whose land tenure was less certain, were at higher risk of crop damage by wildlife and floods. They compensated in part by maximizing productivity of home gardens and by choosing crops that yielded greater economic return. We conclude that home gardens provide a basis for distinguishing between resident and immigrant land use practices.

Introduction

As the rate of forest cover depletion in densely populated regions has increased in recent times, the interaction of demographic and environmental change has received closer attention (Cincotta et al. 2000). Given the complexity of environmental processes, ecosystem resilience, in- and out-migration, plus socio-cultural, behavioral and demographic differences among immigrant groups, much is yet to be learned in order to achieve a balance between conservation goals and the management of landscapes where migration is responsible for population growth. South Asia in general has high population densities, but certain parts of it—and especially the plains of north India—support some of the highest human population densities on earth (Kar 1994).

One important reason for such a high population density has been soil fertility recharged by annual alluvial deposition. The Brahmaputra Valley in the State of Assam is an example of such an area. In such systems, although the land can support high human densities, continuing population growth in the long-term affects land use patterns, farm size and the state of natural resources. Efforts at ecosystem conservation through the establishment of protected areas, or other policy initiatives aimed at regulating forest resource use, can run into conflict with growing human populations and needs for cultivable land, pasture and employment. This is particularly relevant in India where biodiversity conservation has caused dislocation of people from agricultural lands (Agrawal 1992).

The loss of gainful employment and the lack of employment opportunities in rural areas may increase the incidence of marginal farming and—when coupled with a high rate of immigration—does force some immigrants to subsist on land on which they have no tenure (Shrivastava 2002). In addition to the effects of migration on land use, recent research from the Indian Himalayas indicates that seasonally immigrant households have greater resource needs than permanently settled households, with immigrants using more than twice the quantity of fuelwood (Awasthi et al. 2004). On the other hand, immigrants may bring sets of skills that are more developed than those of the residents. For example, refugees from wet rice cultivation areas in Bangladesh who settled the tribal areas of central India are believed by the indigenous Korku tribe to be especially good at earth excavation work (e.g., canal construction) (Awasthi et al. 2004). By their nature and circumstance, immigrants can be more versatile and adaptable compared to residents. They may function as rural extension agents dispensing new skills and showing ingenuous modification of local agricultural systems to increase productivity (Arunachalam 2001).

This paper extends the environment-migration framework to include the home garden production system in Assam. The setting is the wet rice agricultural landscape bordering Kaziranga National Park and World Heritage Site (Kaziranga, Figure 1) interspersed with villages and home gardens. The study was undertaken as part of a broader study on conservation attitudes, perceptions and resource use patterns of those living near Kaziranga, a globally important protected area for many endangered large mammals. Wildlife crop depredation was reported by over 95 percent of respondents, with the Asian elephant (*Elephas maximus)* being the most destructive species (Shrivastava 2002).

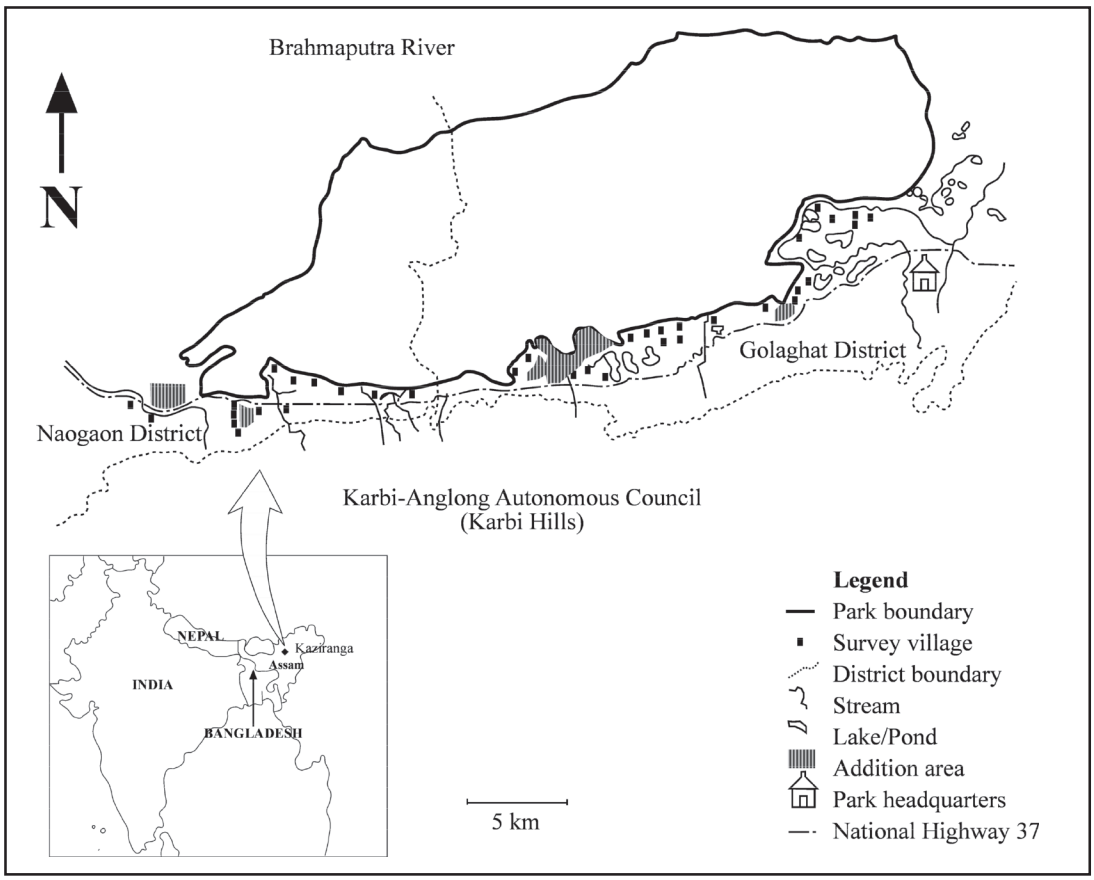

Figure 1. Kaziranga National Park and survey villages in the Brahmaputra Valley, Assam. Map of Kaziranga adapted from Assam State Forest Department (1998).

The Brahmaputra floodplain is ethnically diverse. The area includes residents and recent immigrants of multiple castes and religious groups (e.g., Hindus, indigenous and non-indigenous tribes, Muslims and Christians) who all practice home gardening. Religious groups in India are considered to have different educational, occupational, economic, family, community and other characteristics that justify their designation as ethnic groups (Kurien 2002; Varshney 1998). The main questions that we address are: what are the differences between residents and immigrants in terms of household demography, socio-economics, the size and productivity of home gardens, and what major crops are planted in the gardens? We also explore the interactions of these variables and, for both residents and in-migrants, compare household and garden characteristics as a function of ethnic group. The underlying hypothesis is that residents, by virtue of being local, and thus having more relevant ecological and socio-economic knowledge of the area, are predicted to use home garden resources more efficiently which, in turn, is predicted to result in higher yields and greater economic return.

The People of the Brahmaputra Valley

The population in the study area can be broadly divided into Tribal and Non-Tribal groups following the Constitution (Scheduled Tribes) Order of 1950, which provides a list of tribes in the country. Based on this Order, the State Government of Assam has recognized 23 indigenous tribes. The Brahmaputra River Valley has two major geographic features: the floodplain that is home to the vast majority of Assamese people including the Mishing tribe (also known as Miri), and the Karbi Hills populated by the Karbi tribe (also known as Mikir). Many of the Mishing live in stilt homes; within the study area, this tribe is represented largely in Golaghat District. Mishing homes are situated closer to Kaziranga's boundary. They maintain home gardens, do not practice shifting cultivation, and were more likely to engage in occasional employment than the Karbi who inhabit the hills of the Karbi-Anglong Autonomous Council of Assam in close proximity to the southern boundary of Kaziranga. Some Karbi have moved into the plains as well and Karbi settlements are also found in Nagaon District, within the study area. Although contact with people from the plains is increasing, Karbi are more reticent and wary of outsiders than are Mishing or other people living here, and Karbi settlements still retain a sense of quiet isolation. Karbi home gardens were larger and more diverse in terms of plant species than those maintained by Mishing. The Karbi supplement home garden produce with crops harvested from shifting cultivation and from small plots of paddy cultivation in the foothills.

Non-indigenous tribes in the study area are grouped under the umbrella term 'tea tribes,' derived from the fact that they were traditionally, and continue to be, predominantly employed as labor on tea estates. Their origin is traced to the populous tribes of central India such as the Santhal and Oraon and their socio-cultural attributes define them as unique in the anthropology of Assam. The term 'tea tribe' is still prominent in official terminology and is widely understood. In addition to central Indian tribes, in the mid-nineteenth century the British colonial government tapped other socially marginalized groups for tea estate work. As the tea industry expanded, by the mid 1860s, a well-organized system of labor recruitment from various parts of India was in place that resulted in the migration of thousands of lower-caste Hindus (Xaxa 1985).

Unlike the tribes that inhabit both the floodplain and the hills, the Non-Tribal population of Assam is concentrated in the Brahmaputra and Barak floodplains. They comprise Hindus consisting of Brahmin, Kshatriya, Kayastha, and Scheduled Castes (a category created by an Order of the Constitution of India in 1950), Muslims who preferentially settled the plains transecting the study area, and a few Christian households found in the foothills and valley. The Non-Tribal population has been steadily increasing for some time also as a result of immigration of Bengali-speaking Hindus and Muslims from West Bengal, India and from Bangladesh.

Migration

The migration pattern in the study area was overwhelmingly rural-to-rural, consisting largely of migration within and between neighboring districts of Assam. The process appears akin to

internal migration for cultivable land in the Nepal Terai (Sah and Heinen 2001), although there is also some international migration from Bangladesh and Nepal. About 2.5 million people have moved from Bangladesh into India since 1947. About 1.5 million of them were absorbed in Assam, Meghalaya, and West Bengal (Elahi 1981). Hazarika (1993) estimated that recent immigrants and their children were seven of the 22 million people in Assam in 1991. Nepali livestock herders have also periodically trickled into Assam over the years (Guha 1977), despite the fact that livestock rearing in Assam has not been as ingrained an activity as it is in its traditional strongholds of north-central India and Nepal (Agrawal 1998).

During colonial times, labor migration for tea estates was encouraged by the British and by 1901 the immigrant population of the Brahmaputra Valley was a quarter of the total, with linguistic changes beginning to appear (Guha 1977). Dramatic migration appeared prior to the 1911 census and, based on the 1921 census, immigrants accounted for 55.6 percent of population growth in Assam (Baruah 1999). While early immigrant Santhal and Oraon Tribals confined themselves to work on tea estates, Bengali Hindu and Muslim immigrants vied with the Assamese Hindus and the indigenous tribes for land and employment, which led to potent anti-immigrant agitations. The situation is similar to that of the indigenous Tharu in the Nepal Terai (Chakraborthy 2001), and aptly fits the South Asian land tenure dynamic defined by class and ethnicity (Ludden 2003).

In our study, 43 percent of respondents were first-generation immigrants and their year of arrival in the area ranged from 1917 to 2000. Of these, 96 percent classified themselves as within-Assam migrants and only four percent reported migrating from Bangladesh or Nepal, although respondent self-classification has some problems (see below). Homer-Dixon (1999) contended that the principal causes of large-scale migration from Bangladesh to India were increasing scarcity of cropland in Bangladesh, population growth, and a population density of over 900 people per sq km. Samaddar (1999) questioned such a Malthusian explanation; he cited the failure of water and flood management programs plus socio-cultural inequalities as causing migration.

From 1991 to 2001, Assam's population density increased from 286 to 340 per sq km compared to India's overall increase from 274 to 324 per sq km (Office of the Registrar General 2001). Assam's Human Development Index rank slid from 10 in 1981 to 14 in 2001 of 15 Indian states for which it was estimated. Assam's per capita income in 1980-1983 was 18 percent below the national average and the gap widened to 45 percent in 1999-2002 (Planning Commission of India 2002). In general, the situation in rural Assam is one of declining living standards and continuing immigration. A stagnant economy and unemployment have turned some young Assamese against the federal government, a section of whom have embraced a militant posture in defiance of federal and state forces (Baruah 1999; Hazarika 1994). Immigration has thus become a central issue in Assamese politics.

The Omnipresent Home Gardens of Northeastern India

Since about two decades ago, ethnobotanical research in India has gained momentum. However, home gardens have largely received only tangential reference in studies on vegetables (e.g., Arora et al. 1980; Ramachandran et al. 1980). Although the lack of attention by agricultural research institutions has been decried (Ninez 1987) and baseline agronomic and quantitative data are lacking, there is increasing interest by researchers in the role of home gardening in conservation, development and sustenance.

In rural northeast India, home gardens are ubiquitous landscape components. In addition to the cultivation of vegetables for consumption and sale, home gardens are often sites where certain selected and valued plants collected from nearby forests are grown. Bamboo is the most versatile local plant resource. It is used for house construction, roofing and fencing, baskets, handicrafts, furniture and fishing net poles, while the young shoots are edible. Important edible native bamboos cultivated in home gardens include *Dendrocalamus hamiltonii*, *D. giganteus*, *D. sikkimensis* and *Melocanna baccifera* (Bhatt et al. 2003). Another plant commonly grown in home gardens in Assam and Bangladesh is betel nut palm (**supari** or **tamul**; *Areca catechu* L.) (Nath and Karmakar 2001).

The literature on medicinal plant resources used in the traditional treatment of human morbidity in Assam is, in comparison, extensive (Das and Sharma 2003; Sharma and Boissya 2003), and veterinary and pesticide applications of plant concoctions have been documented (e.g., Bora et al. 2003). Jain and Borthakur (1980) focused on ethnobotany of the Karbi, while Sharma and Boissya (2003) shed light on the Mishing's traditional knowledge of medicinal plants.

Home gardens in Assam also add to local aesthetics. Ornamental plants grown commonly include marigold (**gainda**; *Calendula officinalis* L.) and china-rose (**japapushpa** or **jasum**; *Hibiscus rosa-sinensis L.*); large fruit-bearing trees such as tamarind (**imli**; *Tamarindus indica L.*) and mango (**aam**; *Mangifera indica L.*) are common. Additionally, many plants, fruits, and other non-timber forest products are harvested from forests and from Kaziranga's vicinity including varieties of tubers, hill fern (**dhekia sag;** *Stenochlaena palustris* Burm. f.), chulta (**au tenga**; *Dillenia indica* L.), marlberry (**nal tenga**; *Ardisia colorata* Roxb.), shaddock (**rebab tenga**; *Citrus decumana* L.), carambola (**kordoi tenga**; *Averrhoa carambola* L.), bamboo (**terai**; *Melocanna baccifera* Roxb.), Burmese grape (**liteku**; *Baccaurea sapida* Roxb.), and gooseberry (**aonla**; *Emblica officinalis* Gaertn.).

Methods

The Study Area and Land Resources

The study was undertaken in a 40 km long by 2 km wide belt of land along the southern periphery of Kaziranga, a small segment of the 720 km long Brahmaputra Valley. The Valley is 56,700 sq km in area and is the major geographic feature of Assam. It contains thousands of lakes and ponds that are seasonally replenished by floods and provide fish—an integral component of the Assamese diet. Kaziranga and the study area are spread across Naogaon and Golaghat Districts in central Assam on the south bank of the Brahmaputra River (Figure 1). Kaziranga (area 860 sq km; altitude 40-80 m asl) lies between 26°35´ and 26°45´ N and 93°05´ and 93°40´ E. It is managed from the Park Headquarters in Golaghat District. Six separate 'addition areas' have recently been added to Kaziranga, extending the park to the north to include the bordering stretch of the Brahmaputra River and to the south to include known animal migration corridors and habitats. The climate is sub-tropical with hot summers and cool winters and the rainy season is from May to October with some winter rains. Temperature varies from 5°C in winter to 37°C in summer with high annual rainfall (1,500 to 3,750 mm) and humidity. Heavy floods in the Brahmaputra occur frequently and can displace hundreds of thousands of people. Assam shares international borders with Bhutan and Bangladesh.

Forest cover in Assam in 2001 was 27,714 sq km or 35.33 percent of the land area, much higher than the Indian average of 20.55 percent (Forest Survey of India 2001). Major vegetation types are: Tropical Wet Evergreen, Tropical Semi-Evergreen, Tropical Moist Deciduous, Sub-Tropical Broad-Leafed Hill, Sub-Tropical Pine and Littoral and Swamp Forests. During 1997-1999, dense forest cover (canopy closure of 40 percent of more) decreased by 1,031 sq km (6.67 percent), a significant decline in such a short period, while open forests, (canopy closure of 10-40 percent) increased by 895 sq km (Forest Survey of India 2001).

Dependence on arable land is evident in Assam, where only 11 percent of the people live in urban centers (Office of the Registrar General 2001). In the study area, agriculture was practiced by two-thirds of the population and was the largest source of employment at the time of the study, followed by tea estates. Assam accounts for half the tea produced in India, while rice paddy occupies two-thirds of all cultivated land. Other major crops are oilseeds, legumes, beans, lentils, peas, betel nut and tropical fruits.

The Assam Land and Revenue Regulation Act of 1886 governs land tenure, ownership and taxation. Two main categories of land tenure are recognized in the study area: annual-lease that allows the lessee to pay taxes for occupancy of up to one year with no right of transfer or sublet, and periodic-lease that confers the right to occupy the land for up to thirty years with permanent, heritable and transferable rights subject to taxation (Bhattacharjee 1994). Investing in periodic-lease land is thus more desirable and common among both residents and immigrants.

Selection of Villages and Sampling

District revenue maps (scale: 1 inch = 1 mile) and a Kaziranga management map (scale 1:100,000) were used to identify villages within two km of the park boundary, resulting in a preliminary estimate of 45 villages. Of these, 20 were in Naogaon District and 25 were in Golaghat District. A further selection of villages immediately bordering Kaziranga and its proposed extension areas resulted in a sample of 37 villages. Of these, 14 were in Naogaon and 23 were in Golaghat. We developed a semi-structured questionnaire that was pre-tested and reviewed by Kaziranga authorities; comments were incorporated. A reconnaissance of the area was done in September 2000 and team members were selected in October. We familiarized them with survey objectives, the instrument and its administration procedures during a four-day training period. The first author and two Assamese field assistants, one male and one female, made up the team. Both assistants were local; the man was a high school graduate fluent in Assamese and Hindi, and the woman was a Master's graduate fluent in Assamese, Hindi and English.

Wherever possible, a meeting was held with village headmen prior to beginning the survey to explain its purpose, obtain agreement, and to obtain an estimate of the total number of households in the village. In some instances, the survey could not be initiated on a particular day due to the absence of the village headman. In such cases, it was necessary to re-visit before the survey could be started in that locale. Household interviews were begun in October 2000 after monsoon rains abated. The questionnaire was in English and questions were read in Hindi by the researcher (RJS). The assistants interpreted into Assamese when necessary. The chronological sequence of villages selected for sampling was random. In some instances, weather and road conditions (i.e., they were mostly unpaved) dictated which villages could be visited on a particular day. Sample size was set at 10 percent of the number of households per village, chosen randomly.

The surveys began in the morning and continued until sundown. Sundown varied from 16:30 to 18:30 depending on month. Interviews took about 30 to 40 minutes. No monetary incentive was offered or requested for participation. Over 23 percent of respondents were women. This is rather high for traditional South Asian societies (e.g., Heinen 1993) and may be explained by the fact that we employed a female assistant who was local. All respondents cooperated, although Karbi respondents were comparatively reticent and required a longer period of introduction. Surveys were completed in January 2001.

Survey Constraints and Data Analysis

Reasons for excluding a household from the survey were based on a spot assessment of the respondent, e.g., incapable of understanding or responding due to age, health or mental factors, or otherwise created doubt as to the accuracy of responses. In some instances, respondents had to corroborate factual details (e.g., land holdings, income) from other family members. Although efforts were made to ensure that responses were independent, it was not always possible to seclude respondents from other villagers. Despite efforts to explain the purpose of the survey, some respondents may have had the impression that it was conducted by state, local or park authorities.

Collecting reliable quantitative information on farm income, farm production and wildlife damage can be difficult. Respondents may be reluctant to give complete or accurate information depending on the interviewer's degree of familiarity with local villagers, illegal activities, or how strictly local laws are enforced (Leones and Rozelle 1991). In other cases, respondents may not know details of income or may not remember past income or expenditures. Similar constraints have been observed in other studies when gathering specific time allocation data. Leones (1991) discussed discrepancies in recall, especially at start and end times, and in duration of an activity. Respondents may also under- or inaccurately report activities of other household members. There is also a likelihood (given the sensitivity of immigration in Assam) that some respondents who attested to being within-state migrants had in reality emigrated from Bangladesh.

Data were entered into Excel and analyzed using SPSS 10.0 and Microsoft Excel 2000. The level of significance was set at 0.05 for all statistical tests. Differences between means were tested using 2-tailed

t-tests assuming equal variances. Correlation was tested using Pearson's correlation coefficient. Indian Rupees were converted at 1 $US = INR 45.71 (2000). Land area was converted at 7.32 Assamese **bigha** = 1 ha. Christian households were excluded due to a small sample size (n = 8). Respondents without home gardens and those reporting no production or income from home gardens were also excluded.

Results

Patterns of Migration and Land Use

The population in the study area was divided into two groups, residents and immigrants, based on whether the respondent had immigrated or not. Of the 590 respondents, 334 were residents (56.6 percent) and 256 (43.4 percent) were first generation immigrants. Ethnically, Hindus were the largest immigrant community with Kayasthas accounting for 50 percent of all Hindu immigrants (Table 1). The overriding migration pattern was rural-to-rural. About 96 percent of all immigrants reported moving within Assam, mostly from one village to another within the same district. Immigration incidence was highest in the areas bordering the portion of Kaziranga lying in Naogaon District, and to a lesser extent in the areas bordering Kaziranga in Golaghat District. Immigration into the Kaziranga periphery from the Karbi-Anglong Autonomous Council region of Assam was sporadic (Table 2).

Table 1. Ethnic composition of the immigrant population in the periphery of Kaziranga National Park. (Figures are in percent.)

Brahmin	Kshatriya	Kayastha	Scheduled Caste	Tribes	Muslim	Christian
3.9	6.2	26.6	16.4	23.4	23.0	0.4

Table 2. Immigrants and their place of origin. In Hindus, figures are percent immigrants in each caste. Migrants came from four locations in India and two neighboring countries.

		Place of Origin (%)					
Ethnic Group	Immigrants (% of Group)	Park[a]	Same District[b]	Another District[c]	State[d]	Bangladesh	Nepal
Hindu							
Brahmin	3.1	12.5	50.0	37.5	0	0	0
Kshatriya	5.5	78.6	7.1	7.13	0	0	7.1
Kayastha	26.6	5.9	35.3	57.3	0	1.5	0
Scheduled Caste	16.0	0	61.0	36.6	0	2.4	0
Muslim	21.8	7.1	80.3	7.1	1.8	3.7	0
Tribal	26.6	0	77.9	16.2	5.9	0	0
Christian	0.4	0	0	100.0	0	0	0
Overall		7.8	59.4	28.9	2.0	1.6	0.4

[a]Relocated from inside Kaziranga National Park under provisions of the Wildlife (Protection) Act of 1972
[b]Another village or town in the same District of Assam
[d]Usually Naogaon and occasionally Karbi-Anglong Autonomous Council
[d]Another State of India

Although agricultural land in the study area is fertile, extensive floods have historically been a disincentive to year-round farming. Despite the problems associated with flooding, availability of agricultural land was the main reason for immigration into the area (Table 3). Flooding and soil erosion upstream along the Brahmaputra River had forced many Mishing households to immigrate into the eastern periphery of the park. They cultivate small plots of land and harvest reeds from the Brahmaputra floodplain for sale in local markets. Most employment-based immigration occurred due to opportunities in the nearby tea estates, while some immigrants operated small groceries. In Table 3, the 'Other' column includes reasons for migration such as family disputes, job transfers and social stresses. Seven formerly seasonal migrant Kshatriya households used to establish temporary camps inside the park for grazing cattle. They were relocated outside of Kaziranga following its notification as a National Park.

Table 3. Principal reasons for migration into the study area. Floods and resulting land erosion in other parts of Assam caused some migration. (Figures are in percent.)

Farming	Business/ Employment	Flooding/ Erosion	Relatives/ Marriage	Relocated from KNP	Pastoral	Other
48.6	16.6	16.2	6.7	2.8	2.8	6.3

Land holding is defined here as the sum of productive land, unproductive land, land used for home gardens, and land otherwise occupied. Of the total land holdings in the study area, 70.2 percent was actively farmed and 6.5 percent was unproductive for farming but provided thatch or was used for fishing when inundated. Home gardens comprised 15.8 percent of land area and another 8 percent was under shifting cultivation used mainly by the Karbi for rice and maize. Of the total productive land area, residents held 62.3 percent and immigrants held 37.7 percent. In the case of unproductive land, residents held 47.2 percent while the immigrants held 52.8 percent. Overall, residents held 62.6 percent of land in the study area and immigrants held the remaining 37.4 percent. No significant differences overall in land holdings were evident between residents and immigrants (Table 4). Total land holdings differed between resident Tribal and immigrant Tribal households ($t = 2.13_{250}, p < 0.05$), but not among resident and immigrant households in other ethnic groups.

Table 4. Comparison of landuse and land tenure between residents and immigrants. Productive land comprised of agricultural cropland; unproductive land consisted of land not cultivated due to inundation or other reasons. Periodic tenure implied a 30-year renewable lease (ns = not significant).

	Residents		Immigrants			
Landuse	**Mean (ha)**	**SE**	**Mean (ha)**	**SE**	t_{df}	$p_{(2\text{-tailed})}$
Productive Land	1.09	0.06	1.09	0.08	0.01_{470}	ns
Home Garden	0.27	0.01	0.18	0.01	4.64_{487}	< 0.001
Unproductive Land	0.99	0.19	1.27	0.30	0.81_{41}	ns
Total Land	1.29	0.07	1.10	0.08	1.84_{558}	ns
Land Tenure						
Periodic Lease	1.17	0.08	0.98	0.10	1.46_{347}	ns
Annual Lease	1.06	0.26	1.00	0.13	0.17_{170}	ns
Encroached	0.88	0.18	0.75	0.07	0.90_{206}	ns

Individual households may have a combination of periodic leasehold, annual leasehold and encroached land. Ownership of periodic leasehold land (the most valuable) was reported by 70.1 percent of residents; 31.4 percent reported having annual leasehold land and 32.9 percent occupied land illegally through encroachment. Among immigrants, 44.9 percent reported periodic leasehold, 26.2 percent annual leasehold, and 38.3 percent encroached on land. Thus residents held larger plots of tenured land than immigrants, while immigrants encroached upon larger plots than residents (Table 4).

Home Garden Size, Productivity and Economics

While worldwide there is no optimal size for home gardens, studies in different geographical areas indicate that average size ranges from 0.1 to 0.5 ha (e.g., Dash and Misra 2001; Kumar et al. 1994; Trinh et al. 2003) but gardens up to 2 ha were reported in Sri Lanka (Jacobs and Alles 1987). In our study area, home garden size averaged 0.19 ha and a significant proportion of respondents in both groups had gardens: 89 percent of residents and 75 percent of immigrants. Home gardens comprised 17.5 percent of all land held by residents and 13 percent of all land held by immigrants.

Mean home garden size differed between residents and immigrants (Table 4). Resident gardens averaged 0.27 ha and were 66 percent larger than those of immigrants (0.18 ha). This was true in all ethnic groups, with Kshatriyas and Scheduled Castes having the largest gardens (0.32 ha). Mean home garden size was significantly larger for Hindu and Tribal residents compared to immigrants, but this was not so for Muslims (Table 5). Among immigrants, Muslims established the smallest gardens. Recent immigrants (those arriving after 1970) had smaller plots of productive land (r = -0.19, p <0.01) than those who had arrived earlier, and also had smaller home gardens and unproductive plots.

Not all respondents who maintained gardens obtained produce from them. In our sample, 73 percent of residents and 66 percent of immigrants who had gardens reported harvesting produce. The results are based on respondent estimates of production for a recent normal year of agriculture to eliminate the effects of flood years on production. Of 590 respondents, data for only those residents (n = 245) and immigrants (n = 168) who had home gardens and harvested produce from them were compared. Although resident gardens were significantly larger

Table 5. Home garden size, production, and gross income generated from the sale of produce is compared between immigrants and residents in three ethnic groups (ns = not significant).

	Home Gardens				Annual Production / ha				Annual Income / ha	
Ethnic Group	Mean (ha)	t_{df}	p	SE	Mean (kg)	t_{df}	p	SE	Mean ($US)	t_{df}
Hindu										
Immigrant	0.20	2.90_{197}	<0.005	0.01	10,011	4.04_{180}	<0.0001	1,769.67	527.62	2.06_{100}
Resident	0.28			0.03	2,052			284.99	231.15	
Muslim										
Immigrant	0.13	1.28_{63}	ns	0.02	485	2.33_{31}	<0.05	83.36	2,120.91	1.14_{39}
Resident	0.18			0.04	2,163			891.73	679.08	
Tribal										
Immigrant	0.18	2.29_{216}	<0.05	0.03	1,514	0.51_{189}	ns	181.60	605.79	2.8_{79}
Resident	0.28			0.02	1,371			151.43	101.30	

than those of immigrants, annual production of vegetables and spices was lower. Residents harvested on average 306.3 kg/year while immigrants harvested 816.2 kg/year ($t_{411} = 4.5, p < 0.001$). Per unit area, this translated into production of 1107.6 kg/ha for residents and 4826.4 kg/ha for immigrants. In economic terms, resident households had a median income of US $80.10/year/ha from home gardens, while the figure for immigrants was significantly greater (US $272.30/year/ha). When production data were analyzed by ethnicity, differences between residents and immigrants were significant within the Hindu and the Muslim groups but not for Tribals (Table 5). In the case of Hindu residents, median annual production of 4698 kg/ha was more representative than the mean, which was influenced by few households reporting much higher than average harvest (Table 5).

A comparison of 22 items grown (Figure 2) showed that immigrants obtained higher average yields except for turnip, jackfruit, onion, and co-locasia. The difference was highest for turnip but residents did not report income from it. Jackfruit requires several years to fruit and residents reported income from it, but immigrants did not.

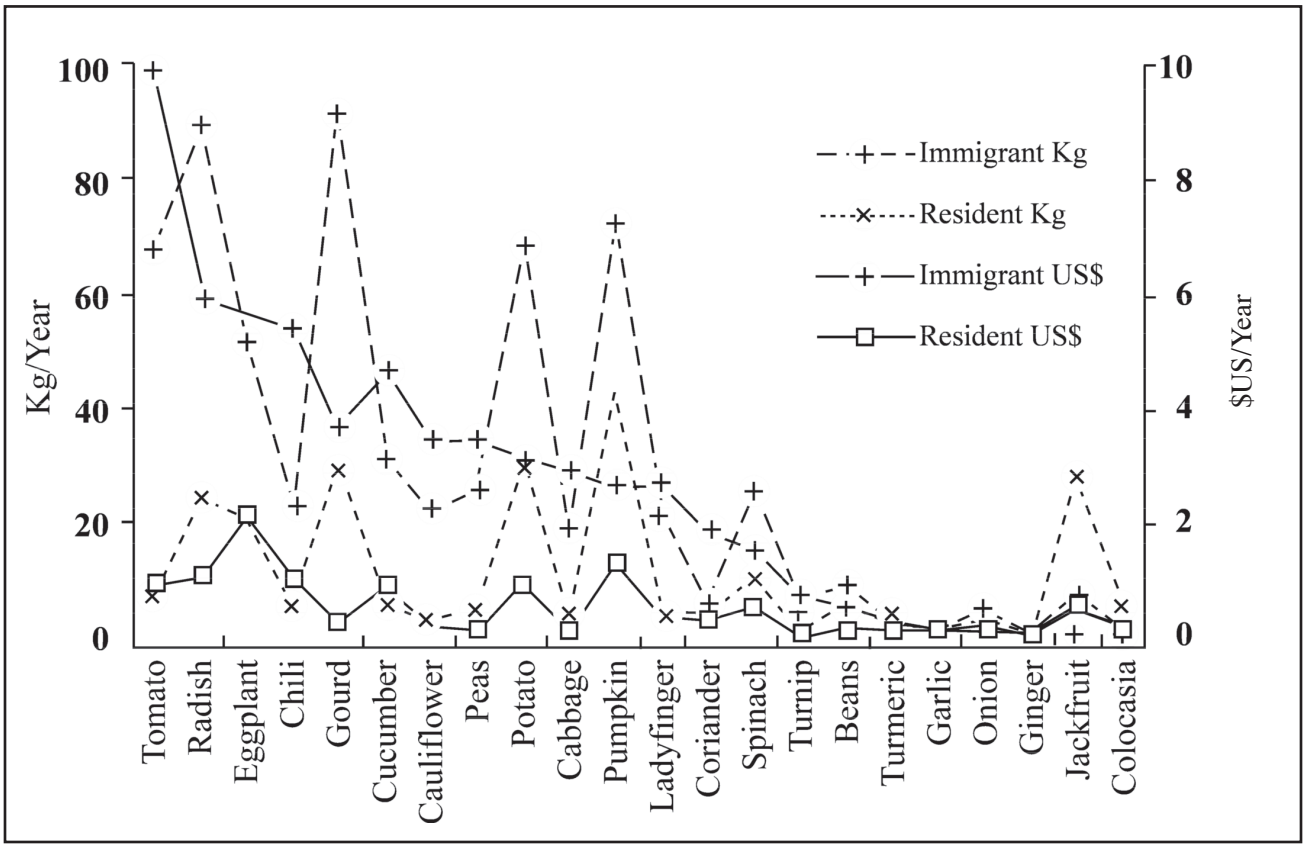

Figure 2. Annual household production and income from the sale of 22 items commonly cultivated in home gardens in the Brahmaputra Valley.

Income from the sale of home garden produce was reported by 33 percent of residents and 46 percent of immigrants. Of those reporting income, residents averaged US $46.60 per annum compared to US $97.00 for immigrants ($t_{272} = -2.05, p < 0.05$). With regard to ethnicity, immigrants in all three ethnic groups consistently reported higher gross incomes than residents from home gardens (Table 5). Hindu and Tribal immigrants earned incomes significantly greater than those reported by residents, but Muslim immigrant and resident gross incomes exceeded those of all other groups.

Some respondents also reported additional home garden income from the sale of fruits such as banana, mango, and lemon. Income from fruits was reported by 36 percent of residents and only 20 percent of immigrants. Of those reporting income from fruits, the mean annual household income of immigrants was US $40.70/ha, which was less than the US $54.10/ha earned by residents; this difference was not significant. To examine whether time elapsed since arrival in the study area influenced immigrant earnings from fruit sale, only immigrants reporting income were selected ($n = 51$). They were divided into two groups based on the median year of arrival (1970), and group means were compared. Immigrants who arrived prior to 1970 had a mean annual household income estimated at US $45.84, which was significantly higher than US $12.10 earned by those who arrived in or after 1970 ($t_{49} = 2.61, p < 0.05$). This indicated that early immigrants did not neglect the future potential of fruit trees in the marketplace.

Discussion and Conclusions

Immigration in Assam is widely recognized as having exerted a disproportionate effect on local demography relative to other parts of India. In the villages along the southern periphery of Kaziranga, a high percentage of respondents classified themselves as immigrants but only about two percent each reported having arrived from another Indian State or from Bangladesh. The pattern that emerges is predominantly that of agriculture-driven rural-to-rural migration occurring largely within Naogaon and to a much lesser extent in Golaghat, creating two zones with distinct immigration characteristics in the Kaziranga periphery, separated by an administrative boundary. It is noteworthy that, while the study area was ethnically diverse, the same was not true at the village level, e.g., Diffalopathar and Lakhurakhunia were predominantly Assamese Hindu villages, Bandardubi and Harmati were predominantly Muslim, while Injaigaon and Mandu-Be were Karbi. The tendency towards ethnic segregation and congregation, together with the fact that Assamese Hindu and Muslim groups had the highest incidence of immigration, suggests that security-related benefits of collective migration (Agrawal 1998) and socio-cultural ties influence village organization and home garden dynamics.

The hypothesis that residents have an advantage over immigrants by virtue of a longer residence and more local ecological knowledge, which could translate into more land, more efficient use of land, and greater economic output from home gardens, is only partly supported. Residents had consistently larger home gardens in the study area irrespective of ethnicity. In terms of overall land use, size of home gardens was significant in distinguishing most residents from immigrants. Among Muslims, the absence of this distinguishing factor indicated a degree of similarity in land use between residents and immigrants that was absent in other groups. Residents in the whole sample owned larger plots of tenured land on average compared to immigrants.

Similar was the situation with leasehold land. However, 70 percent of all residents owned periodic land compared to only 45 percent of immigrants. Thus the size of overall holdings was not an important factor. Instead, immigrants were less likely to own periodic land and compensated in part by using their small home gardens more efficiently in several ways. While a higher proportion of residents owned home gardens and harvested produce, proportionately more immigrants reported earning income from the sale of produce. Overall, production and income from immigrant home gardens were significantly greater than from resident gardens. When ethnic groups were compared, contrary to the overall trend, Muslims immigrants reported significantly lower harvest per hectare. However, Muslim immigrants fetched earnings per hectare that were three to four times those reported by Hindu and Tribal immigrants in the market.

To understand this, the sale prices of six vegetables were calculated and compared among immigrants in the three ethnic groups. Three low-priced vegetables (gourd, potato and spinach) and three high-priced vegetables (chili, eggplant and tomato) were selected because all are widely consumed and grown in the area. Among all immigrants, Muslims obtained the highest sale price for chili and tomato, the two most remunerative vegetables, and the second highest price for eggplant. On the other hand, Muslim immigrants obtained the lowest sale prices for gourd, potato and spinach. Thus, Muslims in general and immigrant Muslims in particular maximized economic

benefits from home gardens by growing vegetables for the high-end sector of the market. We conclude that the size of home gardens and income from sale of produce are two variables that set residents and immigrants apart. In the study area, unfenced agricultural land was largely used for rice and mustard cultivation while home gardens provided a fenced and protected (from wildlife) setting to cultivate a range of vegetables under the vigil of household members. Immigrants adapted quickly by making intensive use of limited land and were not disadvantaged by lack of local ecological knowledge. Since residents controlled more annual and periodic leasehold land, it is likely that they were better off than immigrants economically on average and were not constrained into having to maximize productivity on small home garden plots. Thus the strategies of overall agricultural productivity per household appear to differ based to immigration status, ethnic group and land tenure, but are doubtlessly affected by myriad other variables outside the scope of our study (i.e., closeness to Kaziranga and flood/wildlife damage).

The Karbi Hills were the principal source of a variety of non-timber forest products that often supplement local diet. In northeast India, non-timber forest products are sold in weekly markets, and direct collection is common practice. Since most Karbi villages are located in forests, they had easy access to these products. In wildlife reserves and forests in India that are patrolled by guards, non-timber forest product harvest data obtained through interviews are invariably prone to underestimation. Only 13 percent of Muslims reported harvesting at least one type of non-timber forest product compared to 31 percent of Tribals. Since a much higher proportion of Tribals were residents, this would substantiate the access-harvest concept, although both could be underestimates. Comprehensive study of local ethnobotany will be necessary to understand patterns of use among residents and immigrants and their contribution to home garden composition.

Empirical evidence indicates that wildlife depredation, the inability to punish animals responsible for the depredation, and resulting economic costs to people decidedly induce negative attitudes towards conservation (Heinen 1993). In this study area, intensification of land use, crop-damage by large mammals and flooding are likely to increase economic losses in the park's periphery that immigrants, who disproportionately reside there, will be hard-pressed to avoid. Our data suggest that more intensive use of home gardens, including the choice of more expensive crops, is one way these losses are recouped to a degree by immigrants. Other activities largely outside the scope of this study yet practiced by many people—both resident and immigrant— (e.g., fishing in the park buffer, or illegal sale of timber and fuelwood from Karbi forests) also offer alternative income (Shrivastava 2002). Here the potential exists for conflict over resources, privileges and rights. Where a multiplicity of agencies either control resources or have an interest in resource sustainability, mechanisms for adaptive management, knowledge sharing and inter-agency learning (Klooster 2002) offer a solution. This must go hand in hand with policy initiatives at the national, state and regional levels to comprise a forward-looking strategy that takes into account socio-cultural differences, discourages opportunistic migration to areas least suited to accepting immigrants, and is not divorced from the politics and demographic dynamics underlying forest and land fragmentation in Assam. A great deal of work thus remains to be done if Assam's spectacular wildlife is to coexist with its diverse and dense human population into the future.

Acknowledgements

We thank the interviewees for giving freely of their time, and we acknowledge the Assam Forest Department, and authorities and staff of Kaziranga for fieldwork permissions and valuable assistance. Special thanks go to P.K. Malik for facilitating the fieldwork, and to Debajit, Jyotishmita and Ronjoy in the field. Two anonymous reviewers helped improve the manuscript. The National Geographic Society funded the fieldwork and Rahul J. Shrivastava acknowledges support provided by a WWF-US Education for Nature fellowship.

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