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Housing and Labor Productivity of Female Tea Pluckers in Sri Lanka

Ajantha Kalyanaratne

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Ajantha Kalyanaratne
Department of Economics
University of Sri Jayewardenepura, Sri Lanka

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Comments should be sent to
Ajantha Kalyanaratne
Department of Economics, University of Sri Jayewardenepura, Nugegoda, Sri Lanka.
Email: ajantha77@gmail.com

Contents

Abstract

This study analyzes the link between labor productivity of tea-plantation workers in Sri Lanka and their living conditions. The results indicate a significant negative relationship between Indoor Air Pollution (IAP) vulnerable houses and the labor productivity of dwellers. Our analyses suggest that the productivity of a tea worker living in improved houses is 100% to 151% higher than that of a worker living in traditional, IAP vulnerable houses. We also find that a healthy worker plucks 39% more tea leaves than a worker with a respiratory illness. Since investing in housing improvements and new houses for workers yields significant net benefits to both estate management and estate workers, we recommend that estate managers cooperate with the government to develop better estate worker houses.

Key words

Indoor Air Pollution; Labor productivity; Tea-estate sector; Sri Lanka; Female labor; Benefits to investors

Housing and Labor Productivity of Female Tea Pluckers in Sri Lanka

1. Introduction

Indoor Air Pollution (IAP)[1] has begun to attract the attention of economists only recently, although, historically, it has been one of the most important types of environmental pollution. The World Health Organization, in fact, claims that half of the world's population is exposed to IAP (WHO 2002). This is because some 70% of all person hours in the developing world are spent indoors (Smith 1988a) while in the US, this is 80-90% (Shimer, Phillips and Jenkins 2005; Smith 1988b, p. 12). Some researchers claim that pollutants emitted indoors have a multi-fold greater chance of being inhaled by people than do outdoor emissions (Bennett et al. 2002; Lai, Thatcher and Nazaroff 2000; Smith 1988b).

Clearly, there are linkages between the physical characteristics of a house and indoor environmental pollution (Chapman 2004). A WHO study (2005) identifies poor ventilation inside houses, burning of biomass for cooking and heating, and small housing units as the main factors contributing to IAP. Available estimates show that unprocessed solid biomass fuels release at least 50 times more noxious pollutants than gaseous fuels, triggering ill-health in those exposed to such fumes. Warwick and Doig (2004) find burning of firewood in the kitchen to be the most significant and dangerous source of indoor air pollution as far as residential buildings in developing countries are concerned. In the year 2000, IAP from solid fuel use was responsible for more than 1.6 million deaths and 2.7% of the global burden of disease (WHO 2002) which comes to more than three deaths per minute. Although accurate data are scarce, estimates suggest that in more than 30 countries wood provides more than 70% of the energy needs while in 13 countries it is over 90% (WEC 2007). Thus, it is not surprising that IAP remains a serious health hazard in many countries in the word.[2]

Although researchers have established beyond doubt the significance of the links between housing characteristics and IAP (Clark et al. 2009; Smith, Mehta and Maeusezahl-Feuz 2004), IAP and health (Chapman 2004; Harris and Moore 2009), and health and labor productivity (Oliva-Moreno 2012; Palmer et al. 2010), the direct relationship between housing characteristics and labor productivity remains an under-researched area. Remarkably a few studies have measured IAP and its impact on economic activities (Pearce 1996, p. 629) even though more detailed research on exposure to indoor smoke and its impacts on respiratory diseases in developing countries began in the 1960s and 1970s in India, Nigeria, and Papua New Guinea (Ezzati and Kammen 2002, p. 1057). This study attempts to fill this research gap by analyzing the impact of housing characteristics on the labor productivity of female tea-pluckers in Sri Lanka.

Sri Lankan tea is considered to be the world's finest tea due to quality maintenance through a labor intensive process of selective plucking (Athauda, Ekanayake and Anjalee 2012). Sri Lanka provides 8.5% of the world tea supply, ranking as the fourth largest tea producer. It is also the second leading exporter in the world, relinquishing its position marginally to Kenya in 2007 (Global Tea Brokers 2012; Sri Lanka Tea Board 2011). Tea comprises 59% of total agricultural exports of the country. The tea sector is also the country's largest single employer, providing employment, directly or indirectly, to some 38% of the agricultural sector's employees (Sri Lanka Tea Board 2011).

[1] "Indoor Air Pollution" is defined as "the presence of physical, chemical or biological contaminants in the air of closed environments, which are not naturally present in high quantities in the outdoor air". There are several sources through which quality of indoor air can become polluted. The most common sources are radon (Rn); biological contaminants; environmental tobacco smoke (ETS); stoves, heaters, fireplaces, and chimneys; household products; formaldehyde (CH_2O); pesticides; asbestos; and lead (Pb) (USEPA, 2009).

[2] The World Resource Institute (WRI), quoting the Food and Agricultural Organization (FAO), has claimed that firewood consumption rose by nearly 80% between 1961 and 1998, with the largest increases in Asia and Africa (WRI 2001).

However, there are number of challenges currently faced by the tea-estate sector. Of these, the major concerns are low labor productivity, chronic absenteeism and out-migration of the younger workforce particularly due to bad living conditions in estates, low income and a more fulfilling life outside the rural estate sector (Arunatilake 2001; Athauda, Ekanayake and Anjalee 2012; CEPA 2012; Dunham, Arunatilake and Perera 1997). These challenges are critical to the sustainability of the industry. Since the tea sector is dependent on unskilled resident labor, the industry needs to develop credible strategies to attract a steady labor force and retain existing resident workers. Any mechanisms to increase labor productivity will eventually increase labor income and reduce outmigration. Our study is at least partly motivated by this need to maintain high labor productivity in the important tea sector in Sri Lanka.

Existing cost of illness studies do not capture productivity losses due to illness, since, often, wages are not linked to labor productivity. Rather, it is linked to the amount of time spent at work. However, measurement of labor productivity in tea-estates is relatively easy because work attendance and weight of the green tea leaves plucked by each worker are carefully recorded daily in order to calculate individual wage packets. Therefore, the amount of tea leaves plucked is the best productivity variable to be found in the tea industry (Bradley, Rahmathullah and Narayan 1988; Gilgen, Mascie-Taylor and Rosetta 2001).

Our study is based on wage, productivity and housing data from 1,004 tea-plucker women selected from two tea estates in Sri Lanka. Our findings suggest that the workers living in IAP non-vulnerable house types are up to 148% more productive compared to workers in IAP vulnerable house types. Labour productivity is found to vary among different age cohorts, where younger workers are more productive (32% to 10%) compared to the 56 years and above age cohort. Our estimates also suggest that estate companies can potentially reap significant financial benefits if workers are provided with improved houses.

2. Housing Characteristics and Labor Productivity

There are a number of ways in which the features of a home can affect health. Figure 1 depicts an empirical conceptualization of the impact of house characteristics on labor productivity through IAP and workers' health. As the Figure shows, ventilation, type and size of kitchen, and size of the house significantly increase the possibility of people's exposure to IAP (Bruce et al. 2004; Kumar and Viswanathan 2004; Warwick and Doig 2004; WHO 2005). In addition, interventions to reduce exposure to IAP by installing ventilators are significant determinants of the level of exposure to IAP (Thakuri 2009). Among other common sources of IAP are mould and dampness (Dong et al. 2008; Evans et al. 2000; Hopton and Hunt 1996; Lloyd et al. 2008).

Researchers have identified mould in houses, indoor coal use, ventilation device use, materials used in home decoration, keeping pets inside home and exposure to environmental tobacco smoke (Dong et al. 2011) as significant causes of respiratory symptoms such as persistent cough, persistent phlegm, asthma, wheeze, and allergic rhinitis. Dong et al. (2008) and Hopton and Hunt (1996) have identified mould and dampness in fact to be significant causes of mental illness too.

Freeman (2003) underscores the multiple implications of air pollution impacts on human health, distinguishing among mortality cost (which results in lost productivity), morbidity cost (which leads to reduced productivity, absenteeism and mitigative expenditure), and averting expenditures. With IAP, both morbidity and mortality would negatively affect economic activities. Mortality has an absolute impact on the economy as it absolutely reduces workforce. The morbidity cost of IAP takes several forms among which the major forms are treatment cost, opportunity cost of time, workdays lost, restricted activity days, and dissatisfaction due to illness (Freeman 2003; Warwick and Doig 2004). Loss of productivity has received the most attention in the available literature on economic impacts of IAP as evidenced in studies such Rosen et al. (2000), Gilgen, Mascie-Taylor and Rosetta (2001), and Fox et al. (2004). This study focuses on labor productivity loss as the economic impact of sub-standard housing.

2.1 Indoor Air Pollution, fuelwood use and housing in Sri Lanka

In Sri Lanka, IAP related respiratory illnesses were the second leading cause of hospitalization in 2007 (Ministry of Health 2009). IAP can largely be attributed to energy use within homes. According to the Department of Census

and Statistics (DCS), firewood is still the major energy source, accounting for 53% of total energy consumption in Sri Lanka. Further, almost 80% of Sri Lankan households use unprocessed firewood as their main source of fuel for cooking (DCS 2008, 2009). In rural Sri Lanka, for instance, more than 86% of households use firewood for cooking while in the estate sector,[3] where women prepare food in over 99% of the households, firewood use (at approximately 98%) is well above the national average (DCS 2008). Because firewood is much cheaper than cleaner alternatives such as LPG, most Sri Lankan households use firewood for cooking, placing Sri Lanka at a low stage in the energy ladder (DCS 2009).

The estate sector, which has easy access to fire wood, is particularly vulnerable to IAP because of the small houses available to workers. According to the Department of Census and Statistics, almost 17% of housing units in Sri Lanka have less than 250 square feet of total floor area, while another 40% of housing units reportedly have less than 500 square feet of floor area. In the estate sector, 38% of housing units have less than 250 square feet and 7% have less than 100 square feet in total floor area. In terms of availability of bedrooms, nationally, 23% of households have only one bedroom, while in the estate sector 44% of houses have only one bedroom (DCS 2008).[4]

3. Study Area

We conducted our study in two tea-estates in the Hatton region in Nuwaraeliya district, which is the largest tea-growing region in Sri Lanka. We chose the tea-estate sector for this study for two reasons. Firstly, the up-country tea-estate sector in Sri Lanka remains a unique sector where workers are less influenced by external factors such as political ideologies and employment opportunities. Below-average welfare indicators keep workers both isolated and on the margins of mainstream society (World Bank 2007). Secondly, the tea sector is a unique sector for productivity research because labor productivity is readily measurable.

3.1 Traditional housing in tea estate sector

The estate housing stock consists mainly of back-to-back lines, single lines, single houses, and shanties. Housing for the estate workers is provided by the government although they work for estate companies. Since the settlements of laborers in the estates date back to the 1840's, the traditional housing stock (single and back-to-back lines) in this sector is quite old and living conditions are substandard.[5] According to the Consumer Finance and Socio Economic Survey 2003/04, the percentage of line rooms in the estate sector was 63.4% in 2003 (CBSL 2005). The 'back-to-back lines' and 'single lines'[6] have a smaller floor area with either no separate bedroom or only one. The situation is worse in the 'lines' as 10-15 (or even more) houses are compounded in a single line building, although the average family size is larger than the national average of 4.1. The average family size of our sample is 5.17. In addition to traditional housing, there is also some (about 8%) temporary housing available in tea estates. Very few of these houses have proper ventilation (about 9%) and residents mostly use firewood for cooking (67%). Since the temporary hose dwellers represent the poorer workers, their affordability of ventilation devices or cleaner fuel is very low.

3.2 Housing improvements and new housing

Housing upgrading programs have been undertaken in the estate sector, through which traditional houses have been upgraded from time to time. House upgrading has mainly occurred as improvement in kitchens and re-roofing. We found during field visits that efficient stoves with chimneys have been the most popular change made in kitchens.

In addition, since 1995, the government began to collaborate with the Plantation Human Development Trust (PHDT)

[3] The Sri Lankan economy is sub-divided into three main sectors: urban, rural and estate.
[4] Six percent of houses in the estate sector have no bedrooms compared to only 2.6% for the nation (DCS 2008).
[5] A detailed documentary by the UNDP can be found on YouTube at http://www.youtube.com/watch?v=92UiSzY_kX8 (Date accessed: 19 July, 2012)
[6] This is a typical form of house in the estate sector. A long hall subdivided into several units by a single partition with a mid-wall which is often called "back-to-back line rooms. One family gets a single partition, probably with no separate bedrooms, living area and kitchen. Single lines are supposed to be a little better than back-to-back lines. Mostly hired laborers of South Indian origin live in these back-to-back line rooms.

to provide new improved house units (instead of line rooms) for estate sector workers.[7] As a result, the proportion of single houses in the estate housing stock has increased almost threefold, from 10% in 1996/97 to 28% in 2003/04 (CBSL 2005). Further, PHDT estimates confirm that by 2010, 10% of the estate population had been provided with new single/twin cottage houses in place of their traditional line houses. In addition, living conditions in 50% of traditional lines have been upgraded. While the percentage of the working families living in traditional lines has come down to 32% in 2010, PHDT asserts that overcrowding still remains a significant problem in the estate sector.[8]

Key informant discussions in the field indicate that the selection of estates and workers for Government housing upgrading programs and new housing projects is mostly arbitrary and politically influenced. Since the welfare of the workers is the sole responsibility of the government, estate companies have little or no role in the selection process. Hence, both the allocation of new housing to workers and the selection of houses for upgrading do not necessarily have a relationship with worker productivity.

3.3 Population characteristics

The estate sector population in Sri Lanka was one million in 2001 (DCS 2008).[9] Of this, the population share of the 0-14 age group in the estate sector is approximately 31% of the total, which is somewhat higher than the national average (25%) for the same age group. In stark contrast, the population share of the 60 years and above group in the estate sector is the smallest reported in the country at only 7.5% of the total population in comparison with the country average of 11.3% (DCS 2008). Since the estate sector has a resident worker population, outmigration after retirement is less likely. Therefore the differences in the population shares may indicate bad health conditions or lower life expectancy of the people living in the estate sector.

The average level of education in the estate sector is low compared to other sectors. The population without any schooling in the estate sector is 11.3% which is more than twice the national average of 4.8%. The ratio repeats itself with regard to the people who have completed education only up to Grade 5: the national average stands at 26.5%, the percentage for the estate sector is 47.2%. The share of the population who has completed education up to Grade 10 is 35.9% in the estate sector whereas the national average is 42% indicating lower level of education in the estate sector overall in 1995 (DCS 2008).[10] Refletive of both bad health and lower educational achievement of the estate sector workers is its poverty level. According to the Department of Census and Statistics, estate sector in Sri Lanka has the highest level of poverty incidence with a Head-count Index of 32.0. This is twice the country's overall head-count index (DCS 2008).

3.4 Health care, wages and labour productivity

Provision of healthcare to the estate workers is primarily the responsibility of the Government. After privatization of the estate sector in 1992, both education and health of estate sector have been looked after by the PHDT on behalf of the Government. Most of the tea-estates are freely served by dispensaries and paramedics with a referral system to formal public health facilities, which are also free at the point of delivery. While estate dispensaries are often criticized for poor service quality, generally, out-of-pocket payments for health are minimal for estate workers.

Tea pluckers are bound to a minimum daily norm and it determines the eligibility of a worker for a particular day's payment of wages. If a worker fails to fulfill the daily norm, she becomes automatically disqualified for her daily wage. If a worker plucks above the daily norm, she will be paid an additional payment calculated by the number of kilograms above the norm. The average daily plucking norms in other competitors are well above Sri Lanka. For example, North and South India's minimum norm is around 24-25 kg green leaves per day per worker and for Bangladesh it is 20 kg. Sri Lanka smallholdings have a daily average of 24 kg per worker, whereas in the

[7] The Social Development Divisions of the Janatha Estate Development Board (JEDB) and State Plantations Corporation (SPC) were replaced by a limited liability company: the Plantation Housing and Social Welfare Trust (PHSWT), and was later known as the Plantation Human Development Trust (PHDT). PHDT manages welfare activities of estate plantation workers.

[8] Information provided by the PHDT on the author's request.

[9] The latest census year is 2012. But, disaggregated estimates are not available until now. This estimate is from Household Income and Expenditure Survey (HIES) of the Department of Census and Statistics.

[10] With regard to the level of education of the head of the household, in the estate sector, 53.9% of the household heads have not completed education beyond Grade 5 whereas the national average stands at 27.3% (DCS 2008).

estate sector in Sri Lanka, the daily minimum average pluck is as low as 15 kg of green leaves per day per worker (Yogaratnam 2011).

4. Data and Sampling

This study uses both primary and secondary data on tea-estate workers, their houses, health and productivity. Our data comes from two tea estates that we chose as our study sites based on extensive discussions with several tea estate companies. The two supportive estates were selected with the consent of their respective management.[11] We then conducted key informant interviews with the estate management, estate medical officers, *Grama Niladhari*,[12] *Kangani*,[13] and representatives from among the worker community in order to identify the types of housing available, types of prevailing illnesses, and plucking and leave policies. We used the information collected through the key informant discussions for our sample household survey.

In order to collect primary data on housing characteristics and socio-economic information, we administered a structured household questionnaire survey in 2010 (Annex 1). Our sample consisted of 1,004 tea-plucker women from the two estates. We used multi-stage sampling, in which both convenient sampling and stratified random sampling methods were used. In each of the two estates, we first stratified our sample based on sub-populations of the two estates and their sub-divisions. We then used simple random sampling to identify sample households in each sub-division. Since the study deals with housing characteristics, we tried to avoid any possible overlap in housing characteristics by including only one woman tea-plucker from a particular household. Our survey collected data on physical characteristics of houses, behavioral activities of the dwellers, socio-economic information on the sample workers, and information on their health condition with special reference to IAP-related illnesses and related health expenditure. All the respondents in the sample, except 28, had been living in their current house for more than two years.

From each estate, we collected secondary data on labor productivity of individual pluckers from records kept by the estate management. Productivity data was collected, after identifying the sample for the same 1004 female tea-pluckers whose households we surveyed. Thus, the survey did not bias the information on labor productivity. The productivity data we obtained included information on amount of tea leaves plucked (in kilograms) daily by workers for consecutive twelve months during the period June 2008 and May 2009.

5. Methodology

5.1 Modelling worker health and labour productivity

To analyze the impact of housing characteristics on labor productivity, we develop a behavioral model that is primarily based on methods used in Fenwick and Figenschou (1972), Rosen et al. (2000), Gilgen, Mascie-Taylor and Rosetta (2001), Fox et al. (2004), and Larson et al. (2008).

The empirical model consists of two equations in which housing characteristics affect labor productivity through the health impact:

$$\text{Worker Health} = f\left(\begin{array}{l}\text{Housing characteristics, Occupational vulnerability,}\\ \text{Climatic condition, Mitigative/Aversive actions}\end{array}\right) \quad (1)$$

$$\text{Labour Productivity} = f\left(\begin{array}{l}\text{Worker health, Work experience, Personal attitudes,}\\ \text{Quality of the tea bush, Land elevation, Management}\\ \text{practices, Socio ecoonomic background}\end{array}\right) \quad (2)$$

[11] Tea-estate sector has very restrictive policies regarding information access by outsiders. This is basically due to feudal-like labor relations maintained in the estates.

[12] Tr.Village Officer. S/he is a public official appointed by the government to carry out the administrative duties of the lowest administrative unit of the country, which is village.

[13] These are foremen/overseers in tea-estates, usually appointed by the management from among members of the same community.

The sequential relationship satisfies conditions for a recursive model, which allows us to apply the OLS method to individual equations directly.[14] This is due to the fact that even though housing characteristics cause ill-health in dwellers and, thereby, labor productivity loss, reverse causality may not be possible. One can argue that this permits us to assume zero contemporaneous correlation between residuals in the above equation system, and, in turn, to use the OLS method to estimate individual equations in the system.

As our main motivation is to understand the impact of housing on labor productivity, our empirical estimation focuses on equation (2). Since the equation system in the conceptual framework satisfies the conditions for a recursive model, we use the OLS method to estimate the following model:

$$\begin{aligned} \text{Productivity} = {} & \beta_0 + \beta_1(\text{temph}) + \beta_2(\text{improved}) + \beta_3(\text{newscheme}) + \beta_4(\text{age25}) + \beta_5(\text{age35}) + \\ & \beta_6(\text{ag45}) + \beta_7(\text{age55}) + \beta_8(\text{illiterate}) + \beta_9(\text{nopestivul}) + \beta_{10}(\text{noets}) + \beta_{11}(\text{nodamp}) + \\ & \beta_{12}(\text{underfive}) + \beta_{13}(\text{duration2}) + \beta_{14}(\text{hvisits}) + \beta_{15}(\text{hvisits2}) + \beta_{16}(\text{famsize}) + \varepsilon \end{aligned} \quad (3)$$

The dependent variable of the regression equation (*productivity*) is monthly average productivity of each female tea-plucker calculated using productivity data for twelve months. Independent variables included in the OLS regression equation are as follows.

temph – This is a dummy variable for temporary houses

improved – This is a dummy variable for improved back-to-back or improved single line houses

newscheme – This dummy variable is for worker houses provided under the new housing scheme of the government for the estate workers administered by the PHDT

Our reference house type is 'traditional back-to-back or traditional single line houses'. Therefore the main policy variables are '*improved*' and '*newscheme*' as explained below.

age25, *age35*, *age45*, and *age55* – These four dummy variables represent age cohorts below 25 years, 26-35, 36-45, and 46-55 respectively. Our reference age cohort category is '56 and above'. It is expected that labor productivity of workers will initially increase with work experience (age) and then decline as workers grow old and hence the oldest age cohort be the least productive.

illiterate – This is a dummy variable indicating if worker education is less than grade five

nopestivul – This is a dummy variable indicating worker houses in which pesticides are not used

noets – This dummy variable refers to workers who are not exposed or very rarely exposed to tobacco smoke

nodamp – This is a dummy variable indicating houses in which dampness is not observed during the field survey

underfive – This variable carries number of household members aged 5 and below. It is expected that more children in the family keep female workers more engaged in child care and hence less productive at the workplace.

duration – This variable is the number of years living in the current house.

hvisits – This measures the number of IAP related hospital visits per month by the respondent.

hvisits2 – This is the square of *hvisits* to capture any non-linear impact of number of IAP related hospital visits on labour productivity.

famsize – This refers to family size of the respondent

The most important variable for our analysis is housing stock. Based on our observations, information provided in the key informant discussions, and information from the Estate Housing Survey Report of 1994,[15] we classify estate houses into four categories in Table 1: a) traditional and old houses; b) temporary houses; c) improved houses; and d) houses provided under new housing schemes. All these houses are described in Section 3. Our expectation is that inhabitants of traditional and old houses are much more vulnerable to IAP relative to improved and new houses.

[14] A general discussion on Recursive models can be found in Gujarati, Damodar N. (2004), *Basic Econometrics* (4th edition), New Delhi, McGraw-Hill (Ch. 20) and Green, William H., (1951), Econometric Analysis (7th edition), Pearson Education Inc. (Ch. 10).

[15] Estate Housing Survey Report 1994 is a report prepared for the Ministry of Plantations by a technical advisory committee publication of which was discontinued. PHDT provided a variety of clarifications on this report in various communications with us.

Table 2 provides summary statistics of the main characteristics of the houses and shows the link to IAP.

As shown in Table 2, traditional and old house structures are more vulnerable to IAP when compared to improved houses and houses in new housing schemes. We gauge this based on use of ventilation devices, fuel-wood use, use of safer stoves, use of improved stoves with chimney, access to clean water, access to hygienic latrines, bedroom congestion, and availability of a safer kitchen. For example, only about 10% of traditional houses have improved cook stoves with chimneys, while the average across all types of houses is 17% with cook stoves and chimneys. Similarly, traditional houses have much less use of ventilation devices relative to all other types of houses.

6. Results and Discussion

Our main analysis is aimed at testing whether IAP vulnerable housing characteristics reduces labor productivity. We estimated three OLS specifications for the equation 3 (see Table 4 for OLS regression results). All three models provide consistent estimates for main coefficients with expected signs when converted to marginal effects.[16] Out of the linear, log-linear, and double-log regression models, we selected the log-linear specification over the linear model using the AIC criterion. Therefore, our sensitivity analysis is based on the associations derived from the log-linear regression model reported in Table 4.

Table 4 shows that after controlling for other explanatory variables, female workers in temporary houses are 13% less productive (with a p-value less than 5%) than the base category of workers in traditional and old line houses. In contrast, workers living in improved houses and new houses are almost 100% and 151% more productive respectively relative to workers living in traditional houses.

The results also suggest that younger workers are more productive relative to workers 56 years or older (statistically significant below 10% level of significance). Compared to the base age category of 56 years and above, workers below 25 years are 21% more productivity, while age categories 26-35, 36-45, and 46-55 are 24%, 20%, and 10% more productivity respectively.

Table 4 shows that worker productivity declines by 6% per month per each child aged 5 years and below in the family. Thus, as expected, parenting young children contributes to a decline in the productivity of women workers. Further, a worker is found to be 39% less productive (log-linear of *hvisits* = -0.39 ignoring the coefficient of *hvisits2* since it is not significant and small) per additional IAP related hospital visit per month (Table 4).

6.1 Benefits and cost of improving worker housing

Improving the living conditions of tea-estate workers is supposed to benefit not just the workers but the estate companies as well. While the workers may benefit from both increased wages due to increased labor productivity and the reduced health cost of IAP-related illnesses, tea-estates are likely to benefit from increased labor productivity. Our results suggest that though increased labor productivity will create additional 'above normal' costs, companies will benefit from the productivity gains. This is important given labor shortages from increasing outmigration of the estate labor force.

We calculated productivity gains for companies as well as for laborers, if workers living in traditional and old houses are provided with improved houses or new houses. We estimated these gains taking into account the number of workers in each of five age cohorts (less than 25, 26-35, 36-45, 46-55, and 56 and above). We use the marginal effects of the log-linear regression model for this simulation. Calculations show that the 25-35 age category is more productive compared to other age categories and that productivity diminishes as workers grow older. We then compared such gains with the cost of investments to find out if the investments are worthwhile.

[16] We followed the methods proposed by Halvorsen and Palmquist (1980), Kennedy (1981), and Giles (1982) to calculate marginal effects in the semi-logarithmic regression model. Our calculation procedure is:
Percentage effect of a dummy variable (D_i) on Y (dY/dD_i) = $100^*(\exp(\beta_i) - 1)$
Marginal effect of a continuous variable (X_i) on Y (dY/dX_i) = β_i^*100

6.1.1 Gains to estate companies from investing in new worker houses

Figure 3 presents estimated monthly mean labor productivity using marginal effects for different house types and five age cohorts. Our main interest is in the productivity difference between the reference house type (traditional and old line houses) and the two house types of policy interest (improved and new houses). This difference represents the mean monthly productivity gain from investments in house improvements or new houses.

In order to identify total gains to companies in terms of increased value of tea production from improved health, we needed to convert increased production of green leaves to increases in processed tea. Thus, we first divided the estimated monthly mean per worker productivity gain by the average amount of green tea leaves required to produce one kilogram of processed tea. We assumed that the amount of green tea leaves required to create 1 kg of processed tea is 4.65 kg, as identified by the Sri Lanka Tea Research Institute (Mohamed, Galahitiyawa, & Chandradasa, 2003).[17] This gives us an estimate for the average amount of additional processed tea per month per worker that is produced, if a worker living in old house gets better housing. We then calculated the per worker total monthly monetary gain to the estate companies by multiplying this number by the average auction price per kilogram of processed tea, which was LKR 300 in 2011.[18]

We also considered the additional cost to estate companies from the increased monthly average plucking. Pluckers are paid an additional incentive based on the amount of tea leaves they pluck in addition to the daily minimum norm. We calculated the average additional cost to estate companies based on the assumption that the extra leaves plucked by the worker would fall into the "addition to the norm" category. This is because any plucker generally plucks the daily norm or the minimum daily target in order to be eligible for the daily minimum wage. Therefore, the additional monthly cost to the companies is calculated by multiplying the estimated mean additional amount plucked by LKR 15, which is the average pay for every "above-the-norm" 1 kg of tea leaves.[19]

Estimated per worker annual financial gains and additional costs to companies from house improvements and investing in new houses are presented in Figure 4. The total annual financial gain per worker from house improvements ranges between LKR 110,151($ 847) and LKR 88,679 ($682) with higher returns associated with younger workers. The additional cost to companies in terms of 'over the norm' payments ranges from LKR 26,691 ($ 205) to LKR 20,271 ($ 156) for the respective age cohorts. Further, investing in new houses shows higher financial gains relative to house improvements. In this case, total annual financial gain per worker ranges between LKR 167,270($ 1,287) and LKR 134,663 ($ 1,034) with the same negative association with worker age. For investments in new worker houses, additional cost borne by companies in terms of over the norm payments ranges between LKR 40,048 ($ 308) and LKR 30,414 ($ 234) per worker. Therefore, both investment are viable and provide companies with positive annual net financial gains, although gains diminish with worker age.

Per worker net monthly gain to estates is obtained by subtracting the estimated monthly additional cost from the estimated total monthly monetary gain per worker. This figure was then translated into an annual figure for reporting. We note that in this calculation of gains to companies, we do not yet take into consideration the cost of investment in houses. We discuss these fixed costs in the next section.

Figure 5 presents the calculated annual net financial gain per worker to estates under two types of investments, house improvements and new houses. It reveals that the net financial gains to estate companies by way of increased productivity are highest for the 26 - 35 age cohort under both types of investments. Gains gradually diminish as workers reach higher age cohorts. For house improvements, this ranges from LKR 84,541 ($ 650) to LKR 68,061 ($ 523). Similarly, the per worker annual net financial gains to companies from providing new worker houses is estimated to be between LKR 128,379 ($ 987) and LKR 103,354 ($ 795).

We calculated net present value (NPV) of net financial benefits to estates if workers are provided with new houses under three discount rates[20] using the productivity estimates. Calculations reveal that estate companies are likely

[17] The green tea to processed tea conversion factor (4.65) was further confirmed by tea companies.
[18] http://www.forbesteaportal.com/Insidepages/Statistics/SriLankaWeeklyTeaAuction.html, http://www.pureceylontea.com/auctions.htm (Accessed on: 12/08/2011)
[19] Information provided by the tea-estates. This is the average over-the-norm pay prevailing in the estates at the time of survey.
[20] We used 6%, 7%, and 8% discount rates since the Central Bank Discount Rate ranges between 6.5% (2013) and 7.5% (2009) (www.cbsl.gov.lk and The World Fact Book of the Central Intelligence Agency (CIA) at www.cia.gov).

to earn net financial gains with a positive NPV. For example, assuming that a worker is provided a new house at the age of 18 and that his retirement age is 65 (47 years of potential working life), we estimate the NPV of financial benefits to the company from this particular worker to be LKR 129,527 ($ 996) in the current year under all discount rates. The NPV remains positive even when the worker reaches retirement age at LKR 6,492 ($50), LKR 4175 ($32), and LKR 2,697 ($ 21) under 6%, 7%, and 8% discount rates respectively (Figure 6).

6.1.2 Benefits to workers from investing in new houses

Housing improvement has two types of benefits for workers: reduced health cost and increased wage earnings. Health cost estimates are derived from the section 11.2 of the survey instrument (Annex 1). It includes number of hospital visits per month and average costs per visit on doctor fee, lab costs, cost of medicine, and cost of travelling.

Our sample data show that traditional and old house dwellers have the highest number of average IAP related hospital visits per month (1.54 visits per month) for the entire family while improved house dwellers and workers in new houses have 0.74 and 0.67 number of visits per month respectively. In terms of cost per visit, traditional and old house dwellers bear the highest per-visit average cost amounting LKR 570 ($ 4.38). Workers in improved houses and new houses spend only LKR 475 ($ 3.65) and LKR 342 ($ 2.63) respectively. These health cost figures are found to be insufficient to make a significant impact to household savings. This may be mainly because of the fact that the estate sector is served by an estate dispensary and free public health care services. Therefore, the observed numbers do not include actual health cost in monetary terms. These are only estimates for out-of-pocket payments on health care, which is very minimal among poor people.

We therefore ignore savings to workers by way of reduced health cost when calculating benefits to workers due to investments on house improvements and new housing. Then, the total benefit received by a worker is equal to what a particular company has to pay for that worker in terms of over the norm payments resulting from increased productivity. As discussed previously, per worker annual financial benefits in this form range from LKR 20,271 ($ 156) to LKR 26,691 ($ 205) for house improvements and from LKR 30,414 ($ 234) to LKR 40,048 ($ 308) for new houses.

6.1.3 Cost of investing in new worker houses

We could not locate cost information for house improvements as these improvements are of varying degrees and therefore cost estimates are not unique. We therefore consider providing a new house as the key policy initiative to shift those living in bad housing to IAP free housing. We selected the ongoing estate housing project administered by the PHDT as the reference investment alternative. PHDT provided us with the cost estimates of constructing a brand new 550 square feet worker house under its Estate Worker Housing Project and we used these estimates as the average cost of providing improved housing to workers. This is the incremental cost of shifting workers from an IAP vulnerable house (traditional and old houses in our analysis) to a new safe house. This lump sum cost is estimated to be LKR1,235,000 ($ 9,500) per housing unit.

6.2 Investment options for investing in IAP reduction

If estate companies bear the full cost of new housing, our calculations returned negative NPV estimates for estate companies. However, if the government agency provides better housing to the estate workers, the estate companies enjoy significant gains. Therefore, estate companies may have an incentive to cost share and cooperate with the government to provide improved housing for their workers. For example, the government may be willing to bear a part of the cost of existing estate worker housing project under PHDT, whilst the remainder could be borne by companies and workers together or estate companies alone. Currently, estate companies, for example, cooperate with the government in a estate housing project administered by the National Housing Development Authority (NHDA) by providing a 6 perch land plots[21] and LKR 2,25,000 per house.[22] At the same time, government could also

[21] 1 perch equals 25 sq meters.
[22] Information is available at http://www.nhda.lk/services.php?id=1 (Date accessed: 10 May, 2014)

introduce a low interest loan schemes[23] to finance the cost component borne by estate companies and workers.

6.2.1 Investment potential of estate companies

We calculate per-worker cumulative NPV (CNPV) of the net future financial gains to estate companies from investments on new worker housing if companies bear half the cost of the investment. Assuming that companies receive a concessionary loan from the government (i.e. 8% p.a.) and that repayment period is 20 years, CNVP is calculated under three different discount rates (6%, 7%, and 8%) and at different worker ages from 18 to 46 (over 46 workers may not be eligible due to insufficient work-life for repayment).

$$CNPV_i = \sum (NPV_{it}^{B} - NPV_{it}^{AC})$$

$$NPV_{it}^{B} = B_{iT} \times \frac{1}{(1+r)^t}$$

$$NPV_{it}^{AC} = AC_{iT} \times \frac{1}{(1+r)^t}$$

where; $t = 0,1,2,\ldots\ldots,46$ and $T = 18, 19,\ldots\ldots, 65$

$CNPV_i$ = Cumulative Net Present Value of future net benefits received by company from ith worker

NPV_{it}^{B} = NPV of benefits from i^{th} worker in t^{th} year

NPV_{it}^{AC} = NPV of Annualized Cost of investment (AC) for i^{th} worker at t^{th} year

B_{iT} = Annual benefit from i^{th} worker at age T

AC_{iT} = Annualized Cost of investment (annual equalized premium of the total payable loan amount calculated for 20 years with annual loan interest rate of 8%) for i^{th} worker at age T[24]

r = interest rate

Our calculations suggest that the cumulative net present value (CNPV) of future expected financial benefits to estate companies remain positive and sufficiently large even if companies finance half the cost of worker houses. For example, the cumulative NPV of an investment to a company for an 18 year old worker is estimated to be LKR 1,122,244 ($ 8,633), LKR 958,577 ($ 7,374), and LKR 830,682 ($ 6,390) respectively under 6%, 7%, and 8% discount rate scenarios if the company decides to finance half the investment. When it comes to a worker of age 46, the CNPV of investment is estimated to be LKR 321,225 ($ 2,471), LKR 301,862 ($ 2,322), and LKR 284,499 ($ 2,188) respectively under 6%, 7%, and 8% discount rates. Thus, investing in houses for younger workers yields higher financial benefits to companies, but benefits stay positive even for investments in older beneficiary workers (Figure 8).

6.2.2 Investment potential of workers

The same calculation is repeated for the workers where we calculate the cumulative net present value (CNPV) of future expected financial benefits to workers (NPV of annualized benefit net of NPV of annualized cost). This calculation suggests that the workers cannot afford to invest 50% of the costs of housing, as their net benefits are lower than that of companies. However, workers of all age groups would still be better off when 20% share of the investment is borne by the workers. For example, a worker of 18 years old is estimated to obtain a cumulative net present value of financial benefits worth LKR 230,185 ($ 1,771), LKR 187,610 ($ 1443), and LKR 155,197 ($1,194) respectively under 6%, 7%, and 8% discount rates. For a worker of age 46, the 20% investment decision would still leave her with positive total net present value of benefits, though this will be very small (Figure 9).

[23] Currently the government provides low interest property loans for government servants and some professionals. Those loan schemes have interest rates effective on the beneficiary ranging from 4% to 10%. Government bears the matching contribution of the market interest rate.

[24] ((1,235,000/2)+[(1,235,000/2) x 8% x 20])/20 = Rs. 80,275

7. Conclusion

In this study, the health effect of IAP on tea-estate workers is examined using a non-conventional method, where house characteristics serve as a proxy for indoor air pollution. Our results indicate that there are significant gains to estate companies and to workers if improved houses are provided to the workers. These gains are in the form of increases in worker productivity. No other study has tried to identify the connections between housing and worker health and productivity. However, there is a plethora of studies on the health impact of IAP on the estate worker population, which reinforce our findings.

Current estate housing projects are mostly funded by the government. Our study suggests that there will be significant gains to workers and to estate companies if such projects are continued. In addition, our findings indicate that an effective housing investment program could be designed with partial contributions from estate companies and workers. Our calculations suggest that the benefits are such that estate companies may be willing to bear some 50% of the cost of worker houses. Because of health and productivity improvements, workers may also potentially consider contributing at least 15%-20% of the investment. However, the government's role in terms of providing concessionary financial backing and matching investment will be of immense importance.

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Tables

Table 1: Distribution of house-types in the sample

House type	Freq	Percentage sampled	National estimate[1]
IAP vulnerable house types			
Traditional and old houses	238	23.70	32
Temporary houses	79	7.87	8
Improved house types			
Improved houses	479	47.71	50
Houses provided under new housing schemes	208	20.72	10
Total	**1004**	**100**	**100**

[1] Estimates derived from DCS (2003) and (DCS (2008))

Table 2: House-types and environmental attributes

Mean value	Percentage to the total in each house type						Mean value	
	Use of ventilation devices inside houses	First priority for fuel wood in the kitchen	Use of safer stoves other than improved stoves	Use of improved wood stoves with chimney	Availability of piped water	Availability of hygienic latrine	Bedroom congestion (average bedroom occupancy)	Availability of a safer kitchen (higher the better – max: value=4)
Traditional and old	9.24	74.37	13.03	10.08	76.05	80.25	4.57	1.77
Temporary houses	8.86	67.09	11.39	20.25	81.01	89.87	3.96	1.91
Improved houses	23.00	65.40	23.84	20.25	78.27	87.34	4.22	1.81
New housing scheme	15.05	62.62	18.45	18.45	84.47	97.09	3.65	1.87
All house types	16.95	67.10	19.16	17.45	79.24	87.86	4.17	1.82

Source: Author calculations using sample data

Table 3: Variable descriptions and summary statistics

	Variable	Description	Mean	Std. Dev.
1	age	Age of the respondent	38.01	9.48
2	age25	Dummy - age cohort: Below 25 years	0.09	0.28
3	age35	Dummy - age cohort: 26-35 years	0.34	0.47
4	age45	Dummy - age cohort: 36-45 years	0.33	0.47
5	age55	Dummy - age cohort: 46-55 years	0.21	0.41
6	bedcongest	Number of persons per bedroom	4.16	1.81
7	chimney	Dummy - use of improved wood stove with chimney in the kitchen	0.17	0.38
8	cleanstove	Dummy - cleaner stoves used in kitchen (other than improved wood stoves)	0.19	0.39
9	duration	Number of years living in the current house	27.66	17.27
10	duration2	duration squared	1062.90	922.81
11	famsize	Family size of the respondent	5.17	1.58
12	hvisits	Average number of IAP related hospital visits per month	0.55	0.96
13	hvisits2	hvisits squared	1.23	3.13
14	iapworkloss	workdays lost due to IAP disease	0.78	1.54
15	illiterate	Dummy - educated less than grade 5	0.66	0.47
16	improved	Dummy - improved back-to-back/single line, or improved worker quarters	0.48	0.50
17	newscheme	Dummy - single house (new scheme) or upstairs house (new scheme)	0.21	0.41
18	nodamp	Dummy – dampness is NOT observed in house	0.51	0.50
19	noets	Dummy - worker is not exposed to tobacco smoke by any means	0.28	0.45
20	nopestivul	Dummy - pesticides not used in house	0.77	0.42
21	pesticide	Dummy - if using pesticide at home	0.23	0.42
22	pets	number of pets at home	0.50	0.76
23	pipedwater	Dummy - house getting piped water for drinking	0.79	0.41
24	prod	Twelve month average of tea leaves plucked by a respondent per month	328.43	224.91
25	safecookplace	Place of cooking - better the place, higher the score1	1.82	0.52
26	safefuel	Dummy - safe fuels used in the kitchen2	0.23	0.42
27	safelat	Dummy - a safe (water sealed) latrine is available	0.88	0.33
28	temph	Dummy - temporary house or temporary shed	0.08	0.27
29	tothhinc	Total monthly family income	18581.78	8075.99
30	tradnold	Dummy - traditional back-to-back, traditional single, or old quarters	0.24	0.43
31	underfive	Number of family members under age 5	0.58	0.82
32	ventidevices	Dummy - ventilation devices installed in house or kitchen	0.33	0.47
33	wealth	No. of family members with a permanent income source (proxy for wealth)	2.26	0.90

Note: Variables are in alphabetical order

1. Safeness is determined by observing the place of hearth and availability of ventilation (covered or open) [section 4.1 of the survey instrument]

2. We consider kerosene, LPG, electricity, and biogas as cleaner fuels compared to firewood, agricultural waste and animal dung

Table 4: OLS regression results

MODEL		Linear	Log-linear		Double log
VARIABLES	Expected sign	Dep. var.= prod	Dep. var.= ln(prod)	Percentage change	Dep. var = ln(prod)
temph	-	-23.106	-0.138**	-12.89%	-0.159
		(25.815)	(0.069)		(0.111)
improved	+	155.710***	0.691***	99.58%	0.685***
		(13.795)	(0.061)		(0.062)
newscheme	+	224.613***	0.921***	151.21%	0.882***
		(27.913)	(0.077)		(0.074)
age25	+	34.846	0.187**	20.55%	0.105
		(47.922)	(0.080)		(0.123)
age35	+	53.251	0.217*	24.21%	0.142
		(44.773)	(0.113)		(0.110)
age45	+	56.886	0.183*	20.06%	0.135
		(43.218)	(0.111)		(0.109)
age55	+	17.747	0.091*	9.56%	0.070
		(41.981)	(0.055)		(0.110)
illiterate	+	16.129	0.067	6.88%	0.064
		(15.147)	(0.050)		(0.050)
nopestivul	+	-14.299	-0.065	-6.28%	-0.063
		(15.572)	(0.044)		(0.044)
noets	+	18.069	0.010	1.03%	0.005
		(15.103)	(0.049)		(0.049)
nodamp	+	13.113	0.068*	7.02%	0.068*
		(12.960)	(0.041)		(0.040)
underfive/ ln(underfive)	-	-18.011*	-0.062**	-6.20%	-0.003*
		(9.186)	(0.030)		(0.002)
duration/ ln(duration)	?	1.338*	0.005***	0.53%	0.067**
		(0.728)	(0.002)		(0.028)
hvisits/ ln(hvisits)	-	-86.724***	-0.390***	-38.95%	0.323***
		(13.612)	(0.071)		(0.117)
hvisits2/ ln(hvisits2)	?	12.913***	0.037	3.71%	-0.339***
		(3.591)	(0.025)		(0.116)
famsize/ ln(famsize)	?	5.195	0.028*	2.78%	0.119
		(4.660)	(0.016)		(0.075)
totfaminc/ ln(totfaminc)	?	0.001	-0.000	-0.00%	-0.037
		(0.001)	(0.000)		(0.046)
Constant		123.209*	4.745***		4.602***
		(69.137)	(0.181)		(0.459)
AIC		14000	2000		2000
Observations		1,004	1,004		1,004
R-squared		0.265	0.433		0.431

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Figures

Figure 1: Conceptual framework of the study

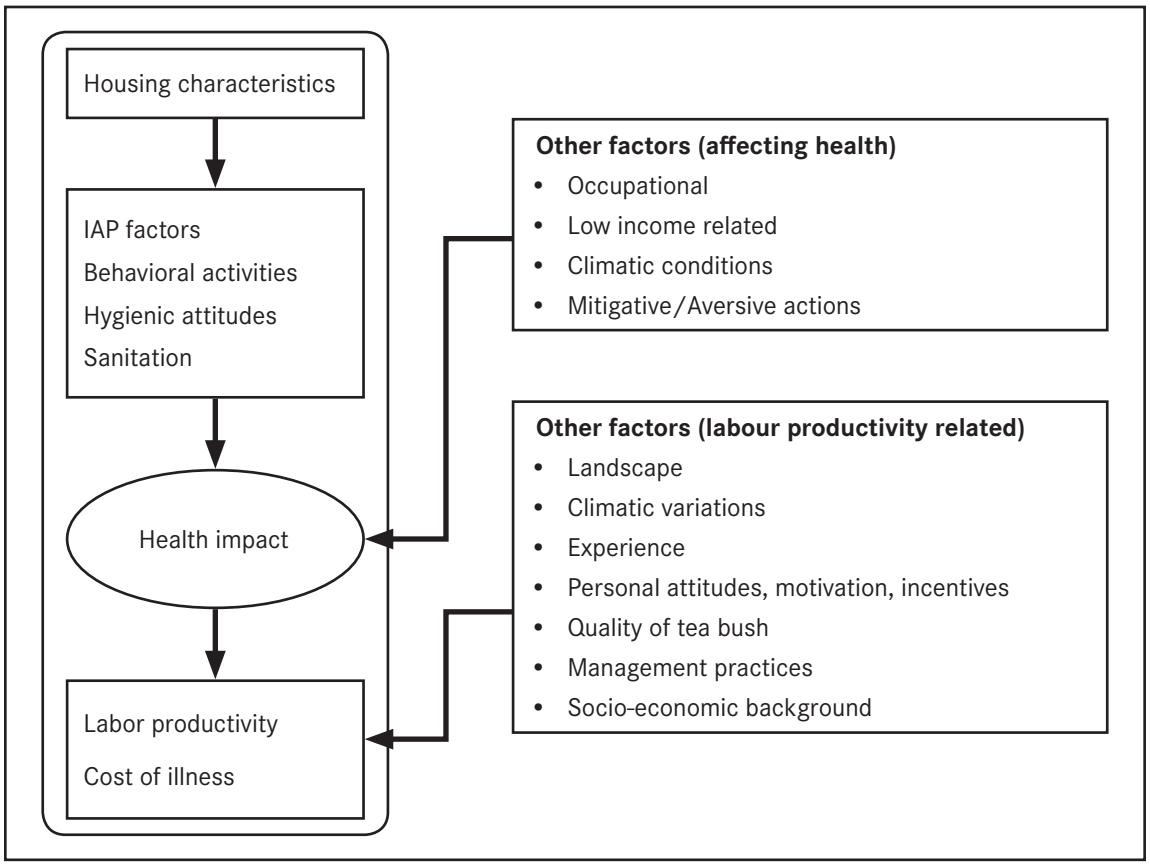


Figure 2: Productivity difference between house types from sample data

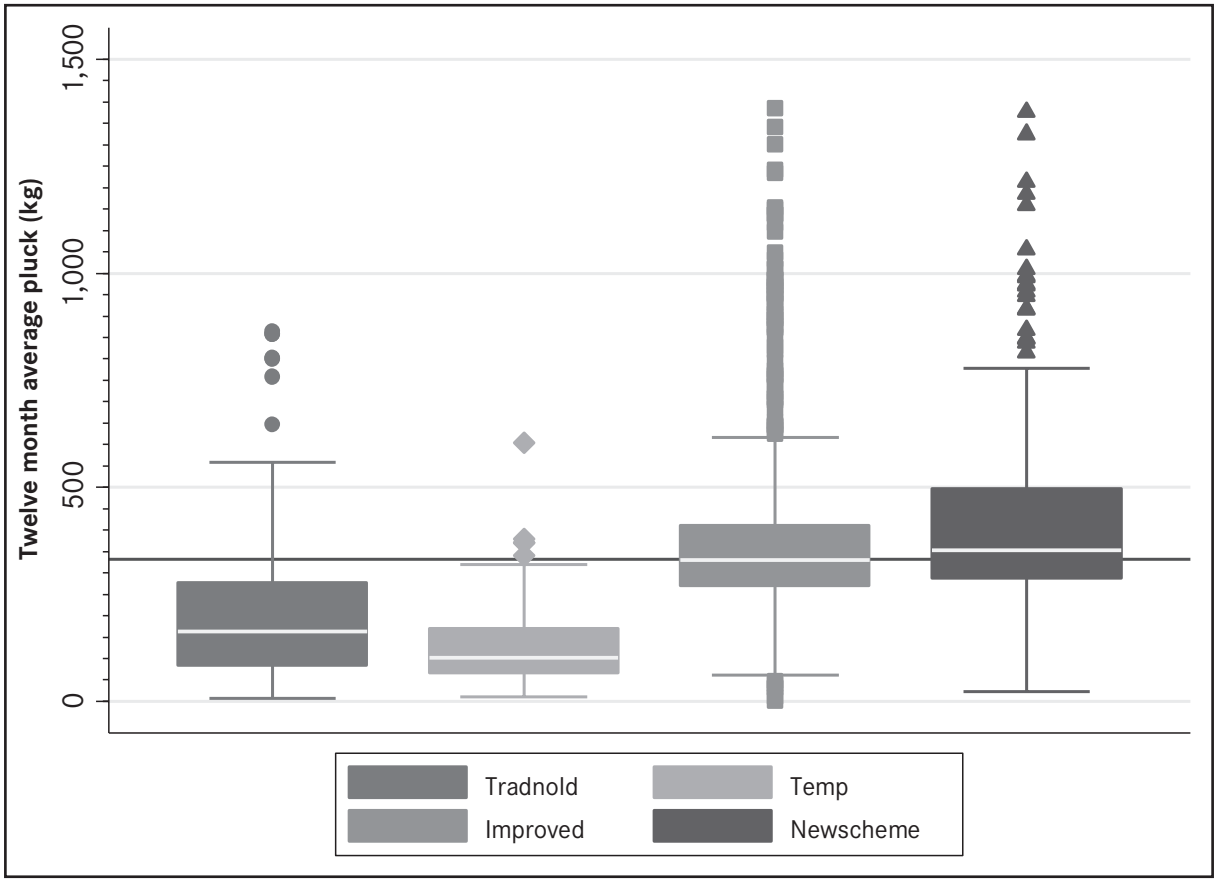


Figure 3: Estimated monthly mean labor productivity by house types and age cohorts

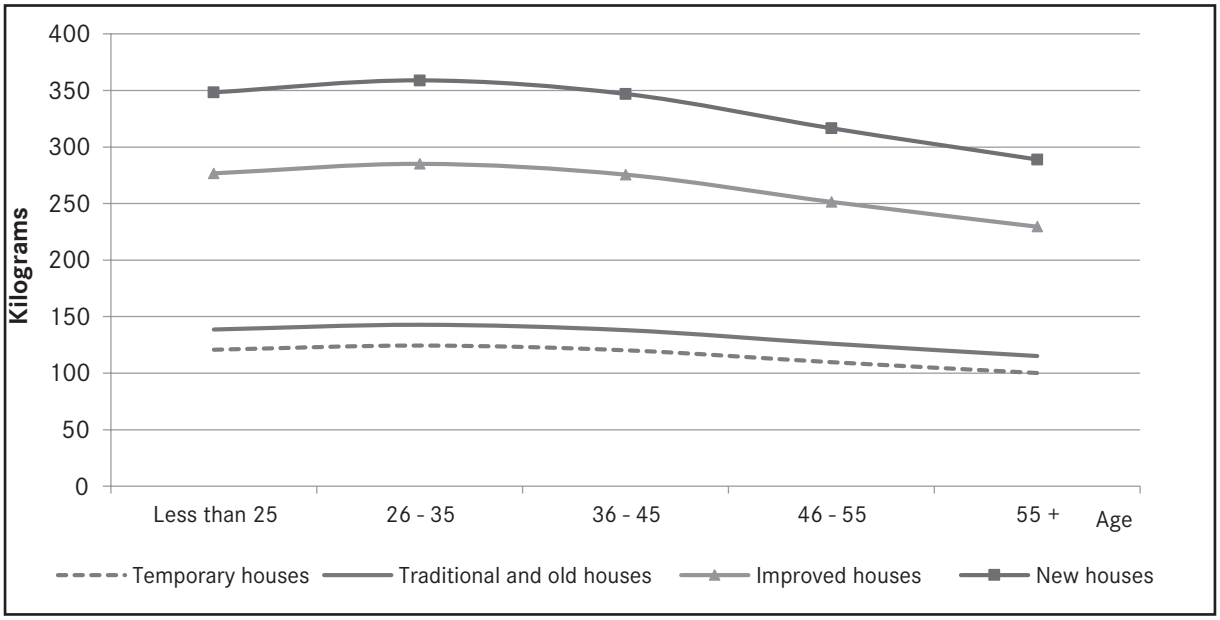


Figure 4: Annual financial gains and additional costs to estates from housing investments

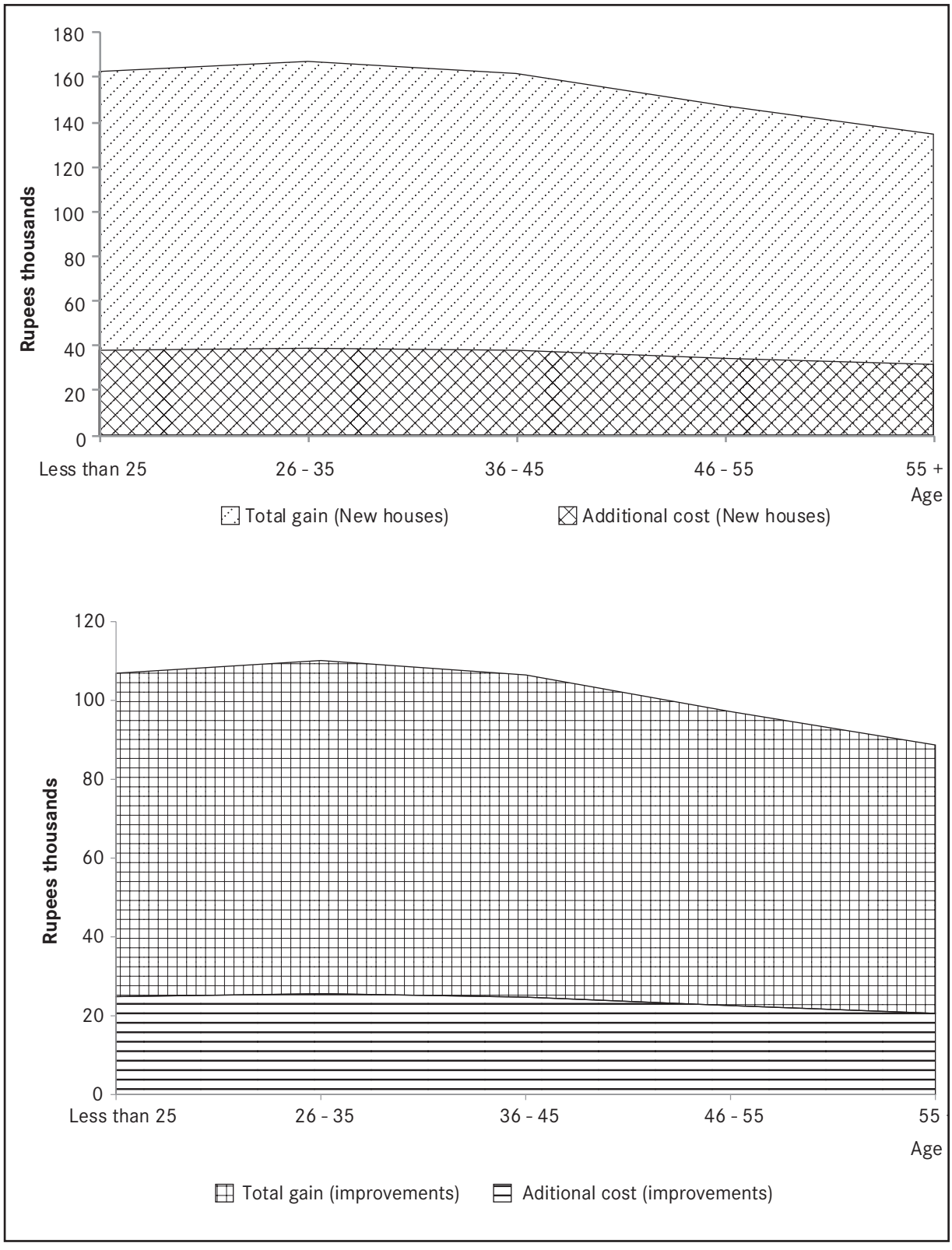


Figure 5: Per worker annual net financial gains to estate companies

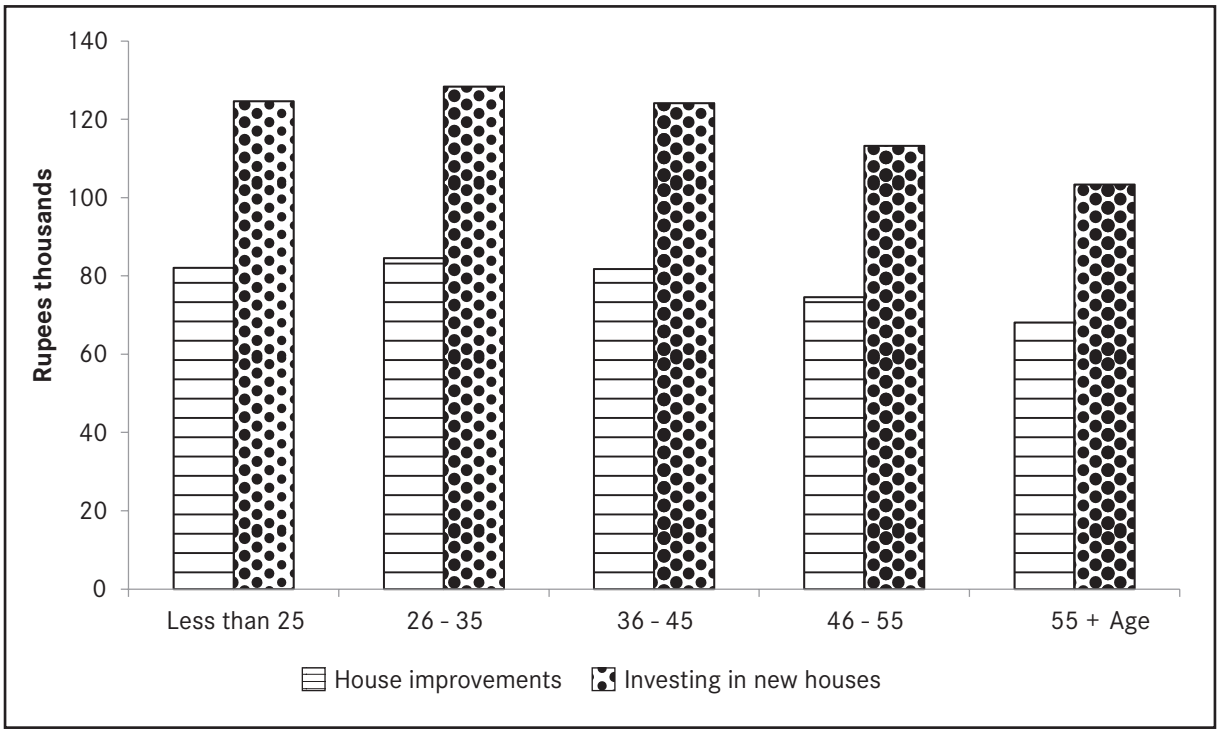
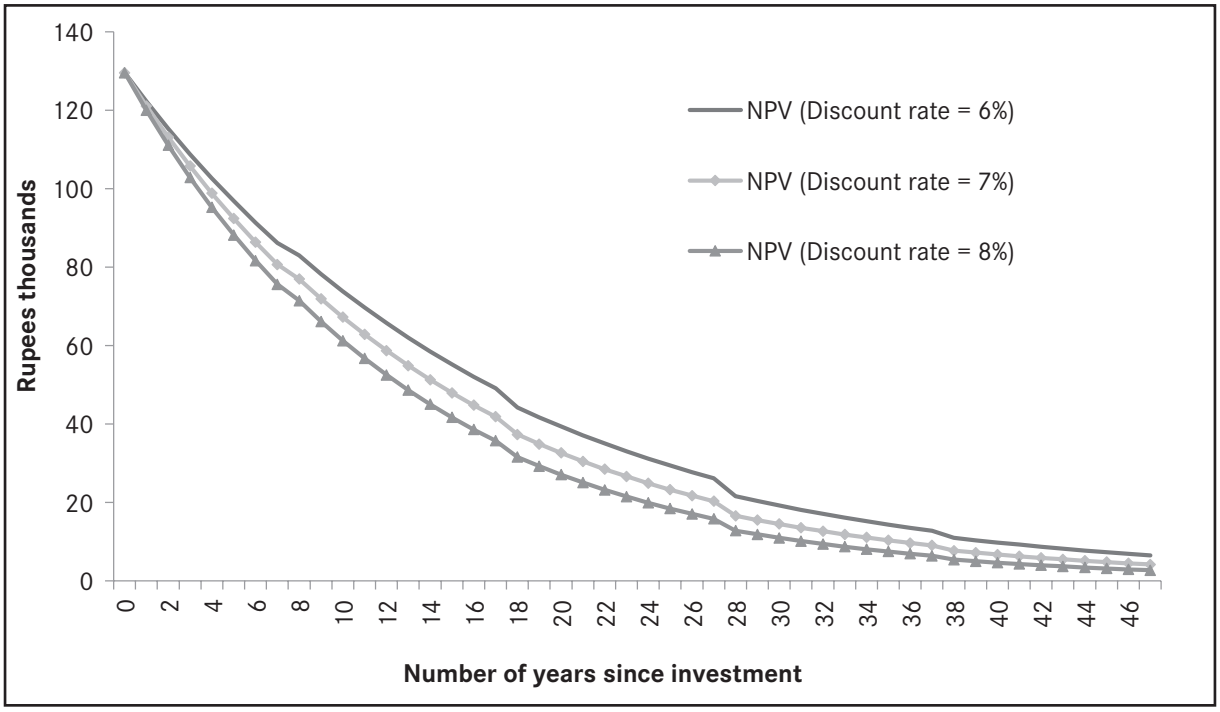


Figure 6: NPV of net financial benefits to estate companies from investing in new housing



Note: for a beneficiary of age 18

Figure 7: Annual net financial gains to worker under two types of investments

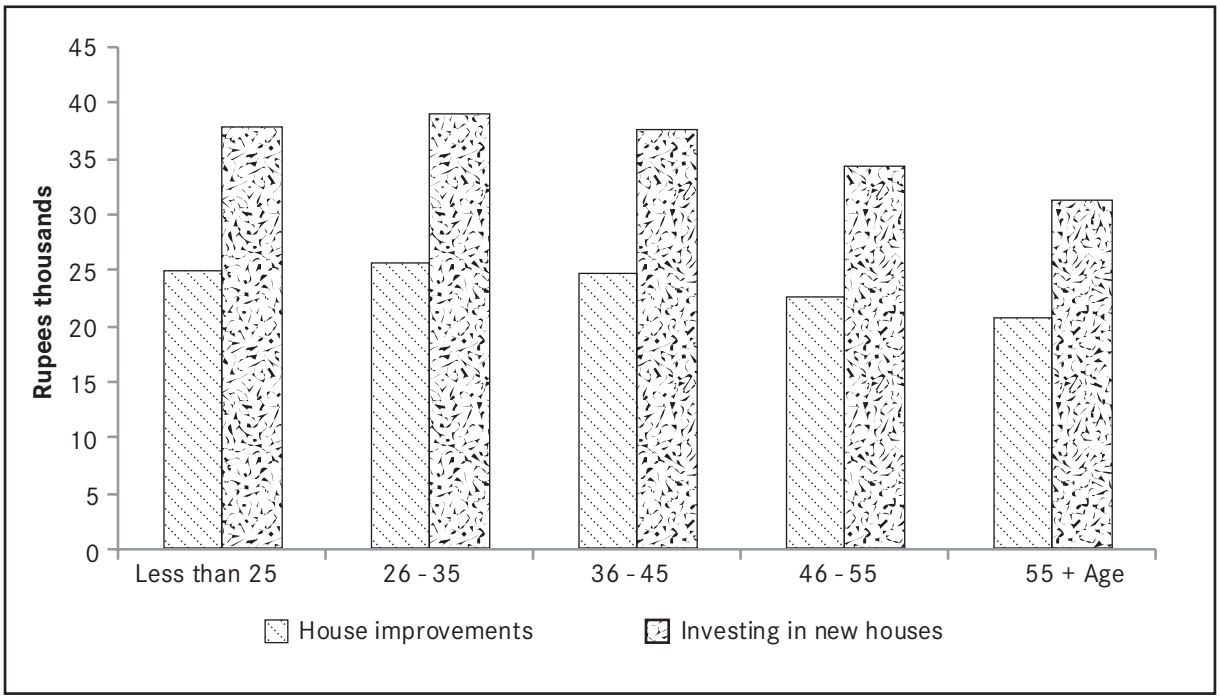
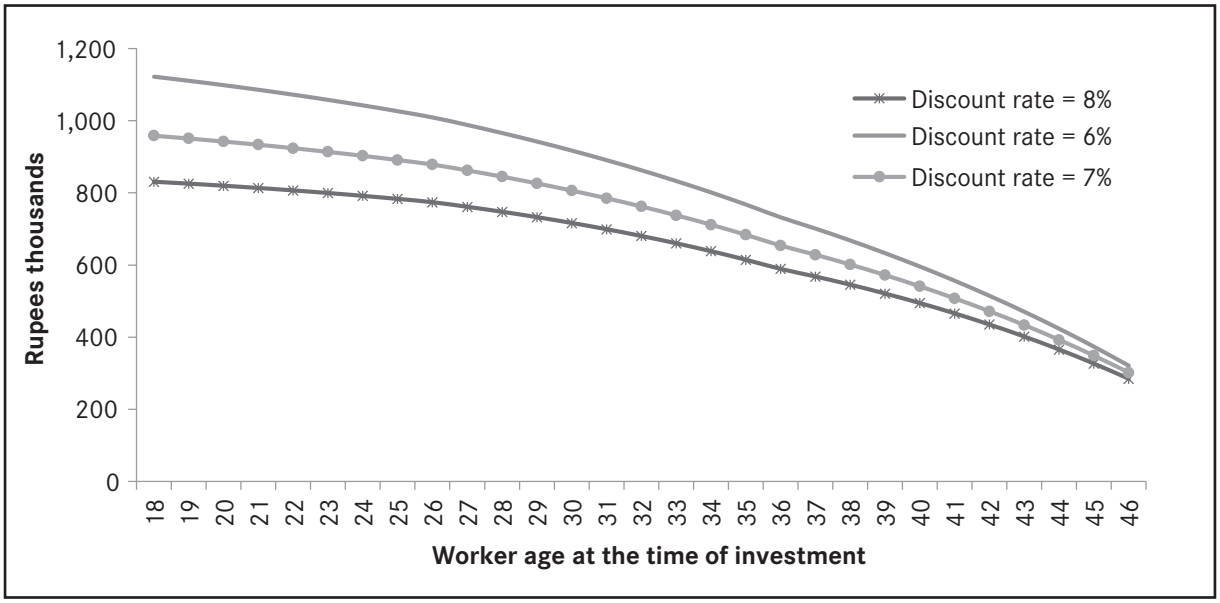
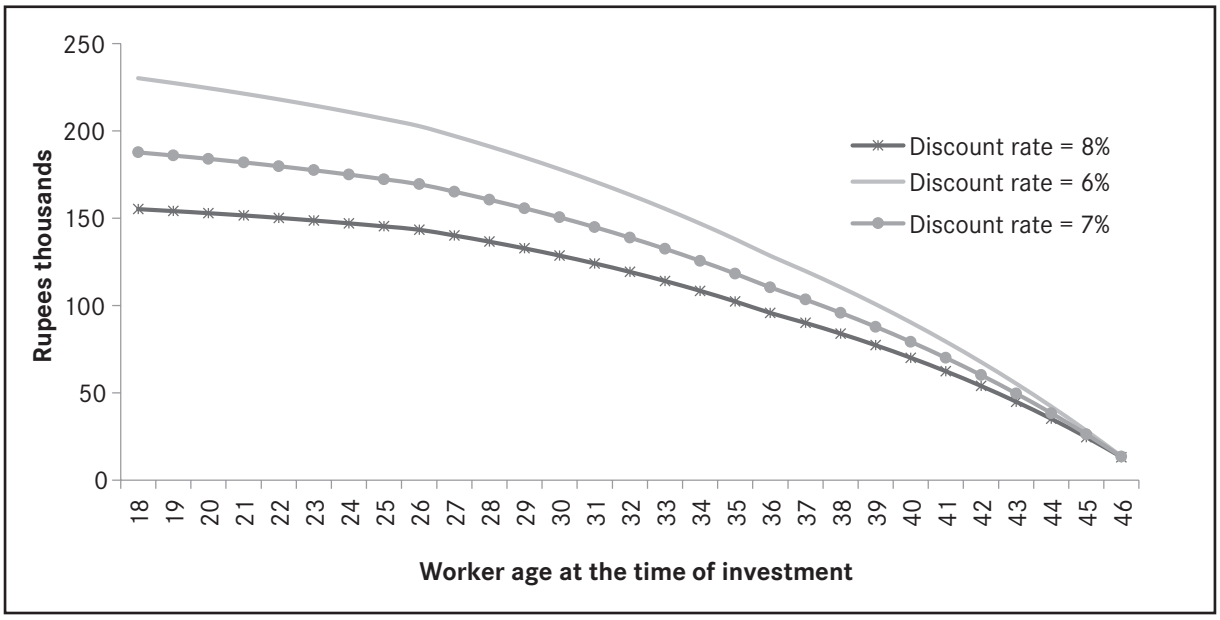


Figure 8: Cumulative NPV of future Net Financial Benefits to an estate company



Note: Estimates are for workers of different ages at the time of investment

Figure 9: Cumulative NPV of future Net Financial Benefits to a worker



Note: Estimates are for workers of different ages at the time of investment

Annex 1: Survey instrument used in the sample survey

HOUSEHOLD SURVEY QUESTIONNAIRE

Study on "The Impact of Housing Environment on the Labor Productivity: Case of Female Tea Pluckers in Sri Lanka"

This survey is conducted for the above research study by Ajantha Kalyanaratne of University of Sri Jayewardenepura with the supervision and assistance from the Kandy Consulting Group (KCG) and the South Asian Network for Development and Environmental Economics (SANDEE).

The information obtained in this questionnaire will not be used for any purpose other than the above study. Personal information provided will be kept confidential and individual information will not be made available to the estate management, government or any other stakeholder. No individual household data will be analyzed and published separately.

Your cooperation in this survey by way of providing accurate information is highly appreciated and duly acknowledged.

Thank you.

Estate Code:			**Enumerator ID:**	
Emp. No. of the Respondent:			**Observation No:**	
Name of the Respondent:			**Time started**	
House No.:			**Time finished**	
			Date:	
House type:				
1 ☐ Traditional single line 2 ☐ Improved single line 3 ☐ Single (cottage) house 7 ☐ Other (specify)		4 ☐ Traditional back-to-back line 5 ☐ Improved back-to-back line 6 ☐ Temporary house		
For office use only:		Remarks		
Classification of house				
Questionnaire No:				

1. Basic information of the household (Please do not include members living outside your house)

Member ID	Relation to respondent[1]	Gender Male = 1 Female = 2	Age	Formal education		Main Occupation[3]	Monthly income (Rs) (*main*)	Subsidiary occupation[3]	Monthly income (Rs) (*subsidiary*)	Other income[4] (monthly) (Rs)
				Level[2]	Finished = 1 Continue = 2					
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

[1] Spouse=1, Father/mother=2, Son/daughter=3, Grandchild=4, Brother/sister=5, Son/daughter-in-law=6, Brother/sister-in-law=7, Father/mother-in-law=8, Other relatives=9, Non-relatives=10, respondent=11

[2] No education=0, Grade 1-5=1, Grade 6-8=2, Grade 9-11=3, GCE (O/L) passed=4, GCE (A/L) passed=5, Graduate/undergraduate=6, Other=7 (Please write in the box)

[3] No occupation=0, Plucker=1, Factory worker=2, Plucking Kangani=3, Factory office worker=4, Factory driver=5, Farmer=6, Self-employed=7, Casual/contracted laborer=8, Business=9, Teacher=10, Salaried (public/private)=11, Housemaid (local)=12, Housemaid (abroad)=13, Other=14 (Please write in the cell)

[4] All income other than the income from main occupation and subsidiary occupation. (scholarships, government subsidies, local/foreign remittances, subsidies in kind, pension, etc)

2. House characteristics

2.1 Room availability

2.1.1 How many bed rooms do you have in your house? ☐ ☐
(*Check and confirm before filling*)

2.1.2 Do you have temporary room partitions inside your house? 1 ☐ Yes 2. ☐ No ☐

2.1.3 Do you have open spaces converted into rooms in your house? 1. ☐ Yes 2. ☐ No ☐

2.2 How many doors you have in your house? ☐ ☐
(*Make sure that the doors are not sealed*)

2.3 How many windows you have in your house? ☐ ☐
(*Make sure that the windows are not sealed*)

2.4 Do you have ventilation devices installed in your house? 1 ☐ Yes 2. ☐ No ☐
(*excluding the kitchen*) (*e.g. wall-fitted air-vents, roof-top air-vents or exhaust fans*)

3. Bathroom

3.1 Do you have a separate bathroom in your house? 1 ☐ Yes 2. ☐ No ☐
(If No, go to Q. 4)

3.2 Do you have any ventilation device/s installed in your bathroom? 1 ☐ Yes 2. ☐ No ☐
(*e.g. wall-fitted air-vents, roof-top air-vents or exhaust fans*)

3.3 Do you have window(s) in your bathroom? 1 ☐ Yes 2. ☐ No ☐
(*Make sure that the windows are not sealed*)

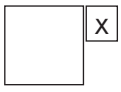
4. Kitchen characteristics (Try to get the person responsible for cooking to answer this section)

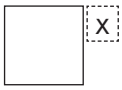
4.1 Where is the kitchen (×) located in your house? (Enumerator to observe)

1. ☐ 

2. ☐ 

3. ☐ 

4. ☐ 

5. ☐ 

6. ☐ 

☐

4.2 How many doors you have (opened to outside) in your kitchen? ☐ ☐
(Make sure that the doors are not sealed)

4.3 How many windows you have in your kitchen? ☐ ☐
(Make sure that the windows are not sealed)

4.4 Do you have any ventilation device/s installed in your kitchen? 1 ☐ Yes 2. ☐ No ☐
(e.g. wall-fitted/roof-top air-vents or exhaust fans)

4.5 How often do you use open space for cooking? ☐
1 ☐ Never 2. ☐ Sometimes 3. ☐ Always (*No regular kitchen*)

4.6 What types of stoves are currently used in your kitchen? (Enumerator to observe)

Stove type	Nos.	If used in the previous year but not now, how long have you stopped using it?
1. Three stone open fire		
2. Semi circular mud stove		
3. Multi-pot stove without chimney		
4. Improved wood stove with chimney		
5. Bio gas cooker		
6. LP gas cooker		
7. Electric cooker/oven/heater		
8. Other (please specify)		

4.7 What types of fuel are currently used in your kitchen?

Fuel type	Rank the usage[1]	Cost (Rs) (per month)
1. Fire wood		
2. Pruned tea branches		
3. Other agricultural waste		
4. Animal dung		
5. Kerosene		
6. LPG		
8. Electricity /solar power		
9. Bio gas		
10. Other		

[1] Rank according to the percentage of use in each fuel (1 = highest, 2= second highest, ..., 10 = least [if all 10 options are available])

4.8 If you are currently using fire wood, tea branches, agricultural waste or animal dung in the kitchen; (if not go to Q 4.9)

4.8.1 Do you use Kerosene while lighting these fossil fuels? 1 ☐ Yes 2. ☐ No ☐

4.8.2 Do you break firewood into small pieces before burning? 1 ☐ Yes 2. ☐ No ☐

4.8.3 Do you dry firewood before burning? 1 ☐ Yes 2. ☐ No ☐

4.8.4 Do you put-off the fire when you finished cooking? 1 ☐ Yes 2. ☐ No ☐
(go to Q. 4.10)

4.9 Were you using Firewood, Tea branches, Agricultural waste or Animal dung during last year? ☐
(if "no" go to Q. 4.10) 1 ☐ Yes 2. ☐ No

4.9.1 How long have you stopped using it? ☐ **months**

4.10 How many cooking sessions do you have per day? ☐ **per day**

4.12 Who cooks food in your house? (please write the member ID from Q. 1.
If more than one, write all member IDs in order of the importance, i.e. high to low importance)

1. ..... ☐ 2. ..... ☐ 3. ..... ☐ 4. ..... ☐

5. Characteristics of the latrine

5.1 What is the type of the latrine your family is using?

1 ☐ Water sealed 2. ☐ Open pit 3. ☐ Use open spaces (*go to Q. 6*) ☐

5.2 Who has the ownership of the latrine?

1 ☐ Family owned 2. ☐ Shared with another family/s 3. ☐ Public latrine ☐

5.3 How often the latrine is cleaned with germicide? (Give examples of popular germicides)

1 ☐ Daily 2. ☐ More than twice a week 3. ☐ Once a week

4 ☐ Not regular 5. ☐ Cleaned but not with a germicide 6. ☐ Never ☐

6. Water

6.1 Where do you get drinking water from?

1 ☐ Piped water (older pipeline) 2. ☐ Piped water (new pipeline) 3. ☐ Well water (own)

4 ☐ Well water (public) 5. ☐ From distribution tank 6. ☐ Tube well ☐

6.2 Do you boil water for drinking?

1 ☐ Never 2. ☐ Yes, but not always 3. ☐ Always ☐

6.3 Does the water you get have any strange smell or taste? 1 ☐ Yes 2. ☐ No ☐

7. Exposure to Environmental Tobacco Smoke (ETS)

7.1 Do you smoke? 1 ☐ Yes 2. ☐ No (*go to Q.7.3*) ☐

7.2 How many cigarettes per day/week on average do you smoke? ☐ **Day** ☐ **Week**

7.3 Do you or other family member/s smoke inside your house?

1 ☐ Yes Most of the time 2. ☐ Yes, but raely 3. ☐ Never ☐

7.4 Do visitors smoke inside your house?

1 ☐ Yes Most of the time 2. ☐ Yes, but raely 3. ☐ Never ☐

7.5 Do others smoke near you?

1 ☐ Yes Most of the time 2. ☐ Yes, but raely 3. ☐ Never ☐

8. Exposure of the respondent to outdoor air pollution

8.1 How often you go to the main city?

1 ☐ Daily 2. ☐ Weekly 3. ☐ ONce in two weeks 4. ☐ Vere rarely 5. ☐ Never ☐

8.2 How far is it to the main road from your house? ☐ **m** ☐ **km**

8.3 Do you think that vehicular smoke enters your house? 1 ☐ Yes 2. ☐ No ☐

9. Nearby pollution sources

9.1 Do you have following places near your house? How far is it from your house?

Place	Distance (meter(s))
Garbage collecting point	meter(s)
Sewage water lodging	meter(s)
Vehicle repairing/Servicing centre	meter(s)
Cattle shed	meter(s)
Broiler farm	meter(s)
Pig farm	meter(s)
Goat farm	meter(s)

10.1 Information about the respondent

10.1 How many days in the previous month on average you could not go for plucking at all due to sickness? **Days** ☐

10.2 How many days in the previous month on average you could not go for plucking at all due to sickness of other family members? **Days** ☐

10.3 How many days in the previous month on average you could not go for plucking at all due to other reasons? **Days** ☐

10.4 Do you pluck until other fellow pluckers finish daily work? 1 ☐ Yes 2. ☐ No ☐

10.5 Do you still pluck even after you reach the daily norm to get more income?
1 ☐ Yes (*go to Q 10.6*) 2. ☐ No ☐

10.5.1 If not, why? (Select the most appropriate answer)

1. ☐ I become exhausted
2. ☐ I just do not look for extra income
3. ☐ Go to other part time work
4. ☐ Due to health reasons
5. ☐ I need to look after children
6. ☐ Other ……. ☐

10.6 Does anybody help you in plucking? (children, husband, etc)
1 ☐ Yes, always 2. ☐ Yes, sometimes 3. ☐ Never ☐

10.7 Do you do less strenuous casual work for the estate other than plucking when you feel sick?
1 ☐ Yes 2. ☐ No (*go to Q 10.8*) ☐

10.7.1 If yes, how many days a month do you do less strenuous work due to sickness?
Days a month ☐

10.8 Do you do any part time work other than working for the estate?
1 ☐ Yes 2. ☐ No (*go to Q 11*) ☐

10.9 How many hours do you do part time work per week? **Hours**

11. Information on the health symptoms of the respondent and other family members

11.1 If you or other member(s) of your household (above 5 years of age) suffer from any of the following diseases/symptoms, please provide following information

Member ID[1]	Doctor diagnosed Bronchitis	Doctor diagnosed Asthma	Doctor diagnosed Allergic Rhinitis	(Fill only for those who do not have doctor diagnosed Bronchitis, Asthma, or Allergic Rhinitis) If sustaining for more than a year....				
				Persistent Cough	Persistent Phlegm	Skin allergies	Shortness of breath	Redness and watery eyes
	Yes=1 No=2	*Yes=1 No=2*	*Yes=1 No=2*	*Yes=1 No=2*	*Yes=1 No=2*	*Yes=1 No=2*	*Yes=1 No=2*	*Yes=1 No=2*

[1] Please write the member ID from Q 1. If this table is applicable to the respondent, use the first row for the respondent

11.2 Please provide cost information for each member of the household on the above symptoms/diseases in the following table.

Member ID[1]	No. of hospital/ doctor visits (per month)[2]	Average cost per visit					
		Hospital/ Doctor fee (Rs)	Lab costs (X-ray, blood test etc). (Rs)	Cost of medicine (Rs)	Cost of travelling (Rs)	Travelling time (hours)	Hospital waiting time (hours)

[1] Please use the member IDs from Q 13.1 in the same order

[2] If using traditional methods, rituals (ex: Ayurvedic, Yantras, Mantras, etc), consider them as hospital/ doctor visits

11.3 If the children (aged 5 years or below) of your household suffer from any of the following symptoms, please provide the following information (Fill only for the children aged 5 years or below)

Member ID1	Child abnormally sleepy or difficult to awake	Fever or low body temperature	Chest pain	Dry cough and later productive to cough with blood stains	Number of hospital/ doctor visits (Per month)2	Time spent on travelling and waiting to see the doctor (hours) (Per visit)	Travel cost on doctor/ hospital visits (Rs.) (Per visit)	Cost of medicine (Rs.) (Per month)
	Yes=1 No=2	Yes=1 No=2	Yes=1 No=2	Yes=1 No=2				

[1] Please use the member IDs from Q 13.1 in the same order

[2] If using traditional methods, rituals (ex: Ayurvedic, Yantras, Mantras, etc), consider them as hospital/ doctor visits

12. How many man days on average do you lose per month due to above symptoms/diseases of your own or of any other member of your family?

Days a month ☐

13. Do you keep any of the following pets at home?

Kind	How many?	For how long?
Dogs		months
Cats		months
Parrots		months
Rabbits		months
Other		months

14. Have you got pest problem in your house? (Explain. e.g. cockroaches, rats, fleas, lice, etc.)

1 ☐ Yes, high 2. ☐ Yes, moderate 3. ☐ NOt at all ☐

15. Do you use pesticides inside house? 1 ☐ Yes 2. ☐ No ☐

16. Enumerator to notice and record.

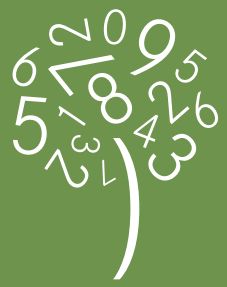
Dampness on floors and walls	1 ☐ Yes 2 ☐ No	
Availability of mould and mildew	1 ☐ Yes 2 ☐ No	
Availability of dust and particles on surfaces	1 ☐ Yes 2 ☐ No	
Availability of spider nets	1 ☐ Yes 2 ☐ No	
Availability of cracks on walls and floor	1 ☐ Yes 2 ☐ No	
Messy house?	1 ☐ Yes 2 ☐ No	

17. How long have you been living in the current house? **Years** ☐

18. What was the previous house type? (Please use house type number from the page 01)

If other (please specify) ……..…….. ☐

Thank you very much for your kind cooperation



SANDEE

P.O. Box 8975, E.P.C 1056, Lalitpur, Nepal

Street address: c/o ICIMOD, Khumaltar, Lalitpur, Nepal

Tel: 977 1 5003222**, Fax:** 977 1 5003299**, Email:** info@sandeeonline.org, **Web:** www.sandeeonline.org

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