LAND TENURE AND FOOD SECURITY IN SOUTH INDIA

Authors:

Hulya Dagdeviren, Arthanari Elangovan, Ramanathan Parimalavelli

ABSTRACT

Tenure security with land titles is considered important for agricultural productivity and growth. In this view, formal titles enable land to be used as collateral, facilitate access to credit markets and increase productivity enhancing investments. Recent studies have extended this approach to food security. This article investigates the validity of the relationship between tenure security and food security by focusing on four different forms of access to land and tenure, ranging from ownership with title deeds to informal access. The research is based on a household survey data, specifically collected for this purpose in a rural setting in Tamil Nadu. In contrast to the studies highlighting the collateral effect, the results in this paper show a negative relationship between credit (debt) and food security, possibly reflecting the influence of indebtedness amongst farming households through debt repayments which constitute a drain on incomes and limit spending on food. Furthermore, the study finds that the probability of food insecurity is lower with both customary and formalised tenure with title deeds in comparison to access to land through tenancy and informal access.

KEY WORDS: Food security, land, tenure security, rural sector, South India

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1. Introduction

Eradication of all forms hunger and malnutrition by 2030 is one of the major objectives of the UN Sustainable Development Goals (SDGs). The role of agricultural productivity and growth as well as equal access to land are recognised as important mechanisms in the achievement of this goal (UNDP 2023). Halfway through the target year, food insecurity continues to be an important problem in many countries, including India, which this study focuses on. The 2022 *State of Food Security and Nutrition Report* by the UN Food and Agriculture Organization (FAO, 2022) shows that over 220 million people in India were affected by undernourishment and around 31 percent of children were stunted in the recent years. This is despite the support provided to more than 60 percent of the population through the Public Distribution System (PDS)[1] under the 2013 National Food Security Act (Chakraborty and Sarmah 2019).

The role of tenure security for economic development has been controversial (Peña et al 2017, Chimhowu and Woodhouse 2006). Those who argued for a positive relationship between the two often focused on ownership with title deeds and emphasised how formalisation enhances tenure security and transforms land into a collateral asset, thereby, enabling access to credit markets (Hoffman 2013), incentivising productivity enhancing investment, for example, in irrigation systems, improved seeds and inputs such as fertilisers or pesticides. Others did not find a credit mechanism, facilitating investment and growth (Lawry et al 2017, Galiani and Schargrodsky 2010). Whether tenure security affects social goals such as food security is also an important question. Recently, some studies considered this question, but the evidence is still inconclusive (Holden and Ghebru 2016, Nara et al 2020, Ibrahim et al 2022).

This paper aims to investigate the relationship between food security and tenure security by focusing on three different forms of land tenure as well as informal access to land without tenure. The research is based on household survey data gathered in South India. Using probability modelling and subjective assessments of the respondents with respect to food security, the study tests for the presence of a significant association between food security and tenure security. Three key findings are worth highlighting. First, when all households are included in the analysis (i.e. landless and landed), all things being equal, access to land with more than one acre emerges as an important factor for food security, irrespective of the form of tenure. Second, when only landed households are included, the study finds that both formalised tenure with titles and customary tenure without titles have a positive relationship with food security in comparison to access through tenancy and other informal access without tenure. Finally, while some studies in the literature find that land ownership with formal titles has a positive impact on agricultural productivity or growth, our findings indicate that if such an impact exists it does not necessarily translate into greater food security. In

[1] PDS aims to improve food security and stabilize food prices. The scheme provides rice and other coarse grains, sugar, oil, kerosene at heavily subsidized prices.

contrast, we find that greater indebtedness (reflecting access to credit) is associated with higher probability of food insecurity.

The paper is structured as follows. The next section provides a review of the literature on the relationship between food security and tenure security. This is followed by a discussion of data and method of estimation in Section 3. The results are presented in Section 4 before summarizing the key contributions of the paper under the conclusions.

2. Literature review: land tenure and food security

In modern times, entitlement failures (e.g. over endowments such as land, other assets and labor) have been more prominent causes of food insecurity as discussed by Amartya Sen in his analysis of famines (1982; 1986). Entitlements and endowments are partly about property rights, which have occupied an important place in the literature with interests in this area ranging from sustainability of natural resources (Hardin, 1968; Ostrom, 1990) to efficiency considerations and the state-market dichotomy (Demsetz, 1967; Alchian and Demsetz, 1972; Alchian and Demsetz, 1973). An important part of this debate focused on land titles and emphasised the role of secure property rights for economic development. Chimhowu and Woodhouse (2006) indicate that Lugard (1941) highlighted the importance of this relationship long before De Soto (1989) and Besley (1995). More recent studies (Kerekes and Williamson, 2008; Hoffmann, 2013; Holcombe, 2014; Hodgson, 2015) underscored the following channels between insecure property rights and lower prospects for development:

a) property/assets without formal titles cannot be used as collateral
b) access to credit would be limited without collateral
c) without credit, long-term investment levels are restricted.[2]

The consequence is that without access to credit for greater investment and value creation, economic activities is expected to focus on simple reproduction and short-term outcomes with negative influence on economic development (Hoffmann, 2013). Formalization of ownership through land titles is anticipated to generate greater potential for agricultural growth and development. This understanding informed the land-titling programmes of the World Bank (Dwyer 2015).

Research outcomes are mixed and inconclusive in this area. Some scholarly work supports a positive relationship between tenure security and investment while others contradict it. For example, Deininger and Jin (2006) and Holden *et al.* (2009) found that enhanced tenure security in Ethiopia, especially low-cost titling, had significant positive effects on investment and productivity. In Malawi, Chirwa (2008) showed that when landless households are given access to land with secure tenure productivity increased as a result of improved access to finance and greater investment in improved maize seeds. A positive relationship between tenure

[2] Other benefits of formal ownership with land titles are also considered in the literature. These include reduced litigation and access to agricultural subsides.

security and investment in farm productivity were also obtained in Ghana (Abdulai *et al.*, 2011). Similar results were reported for Vietnam by Bellemare *et al.* (2020) who showed that the enhancement of tenure security increased the likelihood of investment in irrigation as well as soil and water conservation.

In contrast, other studies found no influence of land titling on access to credit (Galiani and Schargrodsky 2010, Lawry et al 2017). In South America, for example, some studies highlighted the negative consequences of land-titling programmes, generating new land conflicts (Jansen and Roquas 1998) and leading to dispossession of the poor and indigenous communities (Torres-Mazuera 2022). Ruben and Masset (2003) indicate that the land titling programme in Nicaragua led to a significant increase in land sales. Others linked titling to land grabbing (Beban et al 2017). Although the World Bank promoted land titling for a period of time, a major study by its own researchers concluded in 2014 that these programmes had widely failed (Ali *et al.*, 2014). Increasingly, therefore, scholars warn about variegated outcomes of land formalisation programmes and the need for attention to the winners and losers of this policy. Totin et al (2021), for example, discussed how a programme of tenure security in Mali aggravated land conflicts and disparities, especially for migrants and land-poor farmers, while also contributing to a gradual shift from collective farming to individualized practices.

The debates on the interface of tenure security, land-titling, investment and productivity have been extended into food security in the last two decades. Two studies were important in this extension. One is by Maxwell and Wiebe (1999) who discussed how tenure security with land titles would eventually impact food security through credit, investment and associated dynamics (such as productivity and the move from production for subsistence to production for the market). Later, Holden and Ghebru (2016) discussed the links between tenure and food security through the same channel, i.e. access to credit, enabling greater investment and generating productivity effects, higher incomes and consumption.

There is a growing literature on empirical analysis of the relationship between food security and tenure security, paying attention to the varieties of tenure forms and the security they offer in different countries and contexts. Interestingly, a considerable proportion of these studies focus on African countries. For example, Chigbu and Klaus (2013) discussed the difficulties of formalising customary land rights and obtaining land titles in Nigeria and considered the consequences of this for food insecurity. In Ghana, Nara et al (2020) concluded weaker land rights resulted in greater land losses and reduced farm size amongst marginalised groups such as migrant settlers and women and affected their food security negatively. In Zambia, Nkomaki et al (2018) found that food security of households with land titles are higher than those with customary land tenure because farmers in the former group have greater likelihood of adopting sustainable agricultural practices such as crop diversification, intercropping and agroforesty. Similarly, Ajefu and Abiona (2020) examined the investment effects of tenure security for climate adaptation in Malawi and found that tenure security indirectly contributed to food security by supporting adaptation through credit markets.

However, there is considerable variation in empirical findings once the differences in the focus of the studies are considered in terms of forms of land tenure (ownership, customary access, tenancy), social stratification (e.g. gender, migrants vs established settlers, children), pressures (e.g. impacts of climate change) or choice of country or geography. For example, Kobe et al (2022) found that there was no straight forward relationship between food security (measured by health status of individuals) and different forms of tenure security in Nigeria. The findings show that households with formal ownership were less likely to have stunted children while those with informal holding were less likely to have wasted and underweight children.

Limited number of studies exists on this topic in India, despite the existence of considerable research on land and development or food security/nutrition and development.[3] To our knowledge, Santos et al (2014) is the only study, evaluating the impact of land-allocation and registration program in West Bengal, a program that targets the poor and promotes the inclusion of women's names on land titles. In this study, authors were unable to detect statistically significant effects of this program on household food security and argued that these impacts might appear over time. A related study found that it was the land size that mattered in India (Vu et al 2021); having five acres or more land reduced the probability of food insecurity, measured by stunting and height-for-age score, in comparison to landless households.

This study contributes to the growing literature on tenure and food security, focusing on India where limited research exists on this topic. The primary data, collected in South India, enable us to differentiate between different levels of tenure and food security as well as allowing us to account for socio-economic characteristics of households such as the caste they belong to and other agricultural assets they hold.

3. Data and methods

3.1. The Survey

The analysis in this paper is based on survey data collected in 18 hamlets (villages) in Salem District of Tamil Nadu during 2018-2019. We aimed to cover a reasonably large sample of households (over one thousand) in a narrow geographical area for enhanced accuracy of results.[4] Because the study is essentially exploratory, this approach also enabled us to be cost effective while providing replicability for future studies.

[3] See for example, Ramachandran and Swaminathan, Desiere and Jolliffe (2018), Wani, Anantha and Garg (2017), on agricultural productivity, rural credit for the landless or crop management. There are also studies, investigating the role of the food subsidies, impact of climate risks on food security, poverty food-insecurity nexus, the relationship between food and non-food consumption (Kaul 2018, Basole and Basu, 2015, Jha, Gaiha and Sharma 2009). Gendered dimensions of land, development and food security have also been subject of scrutiny (see Agarwal 1995 and Rao 2006).

[4] Using the sample size estimation method of Yamane (1967), outlined in Louangrath (2017), we found that the minimum sample size for this survey was 400 respondent households, given the population of the district (916 thousand households in the latest census) and assuming a confidence level of 95 percent.

Three different criteria were used for choosing the study area. The first is related to landownership structure which is similar in Salem to the overall structure in Tamil Nadu and India as a whole.[5] The expectation is that this similarity may enhance the relevance of the results of this study for other rural areas with comparable social, institutional and land ownership structure in India and perhaps in South Asia. The second criterion is about the importance of agriculture in total economic activities. In Salem, over 40 percent of the workforce is employed in agriculture (GoTN, 2017) and around three quarters of total land area is cultivated.[6] The third is that mixed-cast hamlets were selected to enable comparisons across different caste groups. The hamlets were populated by Backward Caste and Most Backward Caste (BC/MBC) and Scheduled Caste and Scheduled Tribes (SC/ST) as classified by the government of Tamil Nadu. Participants within BC/MBC communities accounted for 54 percent while SC/ST constituted 46 percent of the sample population.

The questionnaire was designed and developed over a year before the fieldwork started. Two pilot surveys were conducted in May 2017 and February-March 2018 before the questionnaire was finalised. The survey contained questions about household characteristics (e.g. household size, gender, age and caste), main sources of livelihood, access to and ownership of land, food support through the PDS and subjective assessments of food security. The fieldwork activities went through institutional Ethics Protocol and Clearance and were based on informed consent, anonymity and confidentiality in the process of data collection. Excluding the pilot surveys, a database of 981 surveyed households was created. Data went through various cleaning and validation processes. This process focused on identifying incomplete, inaccurate and non-conformant responses and other errors in the data. For example, we used data matching by cross-checking the responses to related questions, for example, validating total income with sum of the components of incomes from variety of households activities. Errors during data entry into spreadsheets were identified and corrected through comprehensive inspection of the database. Some respondents did not know the answer to the questions or chose not to answer some of the questions. Overall, therefore, the final dataset is unbalanced, containing missing observations, which were limited in size and random in nature rather than being systematic. Excluding these, a fully balanced data, containing 838 out of 981 respondent households' information, have been used for econometric estimations.

3.2. Measures and determinants of food security

Food insecurity (FIS) studies make it clear that determinants of FIS depend on the context, focus and scope of research. Unlike research based on household surveys, macro studies usually take account of imports and

[5] A large proportion of land is held by marginal and small holders in Salem, Tamil Nadu as well as in India as a whole. According to the most recent census, the following landholding proportions apply at these three geographical levels: over 60 percent of operational land was held by marginal holders with less than one hectare land while small holders with one to two hectares controlled less than 20 percent. The remaining land was held by medium and large landowners (India Agriculture Census, 2015-2016). In the study area, around 70 percent of households surveyed had access to land. A small proportion of this access was to wasteland and pasture (around three percent each).

[6] Main crops are paddy, cereals, groundnuts, tapioca, mango, coconut, arecanut, maize, sugarcane, cotton, turmeric and flowers.

exports of food grains. Food prices are central for research, involving time series or panel data, while they may not be necessary for cross sectional analysis. Estimations based on survey data typically include income as a key determinant of food insecurity (Morioka and Kondo, 2017; (Rammohan and Pritchard, 2014; Tiwasing *et al.*, 2018). Many studies stress the importance of household assets (Harris-Fry *et al.*, 2015; Maitra and Rao, 2018; Shamima *et al.*, 2018). In rural areas, land is probably the most significant asset for livelihoods and food security. Inclusion of variables to account for household characteristics, including age, gender and education, household size, religion, region or location of households is also emphasised (Magaña-Lemus *et al.*, 2016; Abegaz, 2017; Ogundari, 2017).

Reflecting on the literature and considering the specificities of our case study, the following variables are selected for estimation and analysis in this study.

3.2.1 Food insecurity

We use Food Insecurity Experience Scale (FIES) by FAO (2019). FIES is based on participants' subjective assessments. It was originally developed to measure food insecurity in the US. Over time, it has been revised on numerous occasions. The version in 2000 contained 18 questions (Bickel *et al.*, 2000). This was later revised by FAO and USAID to eventually include only eight questions (Coates *et al.*, 2007). Despite some limitations (White, et al. 2016), subjective food security assessments have been widely used in social sciences (Jensen 2002, Noy and Sin, 2021) because obtaining accurate medical measures of food security (e.g micronutrient deficiency) is costlier (Hossain, et al. 2019). Besides, some scholars view subjective data to be a better alternative to narrowly focused economic indicators (e.g. GDP as a measure of quality of life) as they reveal individuals' own perceptions about their status and progress in life (Stiglitz, et al. 2009). We acknowledge the drawbacks of subjective assessments. On balance, however, FIES is likely to generate an invaluable *proxy* in relation to food (in)security.

FIES takes either household or individual as a reference point. Timeframe could vary from one month to 12 months. In this study, we used household as a reference point and covered the last 12 months prior to the survey. This is because rural livelihoods are affected by seasonal variation in agricultural production. For example, households relying on wage labour may not 'run out of food' during the cultivation and harvest periods when there is plenty of work available while they may experience it more frequently outside these seasons. We reduced FIES questions from eight to seven, as listed below, because it became clear during the first pilot study that respondents found some of the questions repetitive and this created a risk that the participants may not remain engaged until the survey is completed. In short, the food insecurity measure in this paper is based on data obtained through two questions in the survey. The first was the following: In the last 12 months, have you or other members of your household experienced any of the followings due to lack of money or other resources?

1) Run out of food
2) Worried about running out of food

3) Skipped a meal in a day
4) Gone without eating a whole day
5) Eaten less than you thought you should
6) Eaten only a few kinds of food
7) Unable to eat nutritious food

Figure 1a in the next section provides the incidence of each dimension across the sample population, with dimension (6), i.e. limited variety of food consumption, being most common while the dimension (4), not eating a whole day, being the least common. Many families experienced more than one element of food insecurity as shown in Figure 1b. Accordingly, close to 24 percent of food insecure families only experienced one form of insecurity and around 11 percent experienced all seven forms of FIS.

The second question aimed to ascertain the frequency of food insecurity. Participants who responded positively to the initial question were asked 'how often' they experience different forms of insecurities identified above and required to choose one of the following options: never, occasionally, sometimes, every week or every day.

Our estimations are based on a categorical food insecurity indicator. Using a 4-point Likert scale, ranging from 0 to 3, we established four different levels of food security. Recall that the questionnaire classified seven different forms of FIS ranging from hunger and inadequate food intake to lack of food diversity and nutrition. Frequency with which each form of FIS is experienced is classified as never (0), occasionally (1), sometimes (2), every week or every day (3). When a respondent opted for 'never' for all seven questions the sum of scores would be zero (0). When a respondent considered that his/her family experienced all seven forms of FIS every day or every week, the sum of scores for his/her household would be 21. Given the minimum score of zero and maximum possible total score of 21, the following is used as a *composite FIS indicator*. Households with a total score of:

0 are classified as food secure (FIS: 0)

Up to 7 are classified as food insecure at a low level (FIS: 1)

Up to 14 are classified as moderately food insecure (FIS: 2)

Over 14 are classified as highly food insecure (FIS: 3)

In this *composite FIS* measure, different dimensions of food security are ascribed equal weights but frequency with which they are experienced is assigned differential weights as indicated above. Robustness of estimations have been checked by complementing composite FIS estimate with nutrition-based FIS and hunger-based FIS. The former measures FIS on the basis of nutritional experience only (i.e. ate less, ate few kinds and ate non-nutritious food) while the latter scores it on the basis of the experience of hunger only (i.e. skipped meal and gone without eating a whole day).

3.2.2. Tenure security

Forms of land tenure is complex and come in variety of geographically differentiated ways and security of each form differs from one country to another. For example, Charoenratana and Shinohara (2018) indicate that a private tenure type in Thailand allows households to use all rights except for the right of alienation. Chimhowu and Woodhouse (2006) indicate, contrary to expectation, that land under customary tenure without land titles can be bought and sold in informal markets in many African countries. Tenure security is assessed in different ways in the literature, including existence of land titles, risk of eviction and expropriation (see Arnot *et al.* 2011 for a review). For instance, Brasselle *et al.* (2002) distinguish between use, exclusion and forms of traditional transfer rights in Burkina Faso in a rural setting where legal ownership is not the norm. Risk of private encroachment and land grabbing is considered as an additional source of tenure insecurity (Holden and Ghebru, 2016).

Land tenure in this paper is divided into four categories from most secure to least secure. The first is land owned with title deeds (*patta*). The second is *customary tenure* which accounted for the largest proportion of land access without title deeds (52 percent). This is land passed down from generation to generation where the families did not obtain the title or the land was registered on the name of a deceased kin. Customary holdings are relatively secure and recognised by the village / community. Although they are not subject to risk of appropriation by the state, they can be exposed to intrafamily conflicts and disputes. These types of holdings cannot not be used as collateral. The third category belongs to formal or informal *tenancy* agreements, including sharecropping, short-term renting and longer-term leasing). These accounted for 10% of land holdings without title deeds. The fourth is *informal access* to land without tenure but with or without permission. This includes land used for grazing by herders, who usually have permission from the village administrative offices, accounting for around 23 percent of the access without land titles. A small proportion of informal access is by squatters, often using state-owned land (locally known as the *poramboke* land).

3.3. Other variables

While the focus of this paper is on the relationship between land tenure and food security, the following were also included in estimations to account for the influence of other relevant factors as well as household heterogeneity.

Land size is measured through a categorical variable ranging from zero to three: landless households (0), marginal holders with up to one acre (1), small holders with more than one acre and up to five acres (2) and medium and large land holders with over five acres of land (3).

Household income reflects the annual earnings of households from a variety of activities, including the imputed value of production consumed within the household. Income data has been equivalised to account for differences in household size, using the OECD equivalence scales (OECD Undated). Income from non-

agricultural employment (expressed in proportion to total household income) is added to measure if livelihood sources outside agriculture has a distinct relationship with food insecurity.

Other assets: Estimations included data on whether respondent households had livestock, irrigation facilities (wells and irrigation canals) and tractor.

Access to credit: As discussed earlier, the literature highlights the importance of access to credit for higher output and greater food security. Land can be used as collateral if tenure is secured with land titles. Therefore, the estimations included a credit access variable, measured as the total debt stock (in Indian Rupees) each household had at the time of the survey.

Food rations provided through the Public Distribution System (PDS) is important in India. In this exercise, we used monthly quantity of rice obtained per household to measure the relationship between the PDS and food security.

Finally, a set of other variables were added to reflect household characteristics, including a binary variable of caste, couples' average age and years of schooling (or the age and education of the respondent in one-member households) and number of working adults in the household.

3.2.4. Econometric estimations

Regression estimations were carried out on two samples:

a) the first set of estimations involved the full sample including both landed and landless households to test for the significance of access to land for food security, irrespective of forms of tenure,
b) the second set of estimations included only landed households and compared access to land without tenure against three different forms of access with tenure: land owned with titles, customary tenure (family land without titles) and land tenancy.

While the issue of endogeneity is not a matter of concern for most variables discussed above, there is potential endogeneity between food insecurity and the PDS entitlements, that is, FIS may depend on the level of the PDS and vice versa. Likewise, household debt stock (credit access) and food security may be interdependent. If such a relationship exists, it may reflect three different effects. The first is that food insecurity may influence the level of household borrowing. That is, households may borrow to satisfy their basic needs.[7] The second is the conventional effect of access to credit, i.e. borrowing may enhance food

[7] This scenario is particularly conceivable given production and market risks in agriculture where real or monetary returns can be volatile over time due to climatic conditions or price fluctuations. The impact of such risks on food security of families are likely to be compounded in rural areas where over 60 percent of the farmers have marginal holdings as is the case in Salem, Tamil Nadu and India.

security via investment and productivity effects. The third is that borrowing for investment or other purposes may drain household food budget through repayment obligations.

The decision about the estimation method has been made in two steps. In the first step, Instrumental Variables approach (two-stage least squares, 2SLS) was used to test whether the PDS and household debt stock indicators are endogenous. Wu-Hausman test statistics below show that both variables are exogenous. When endogeneity test fails, it is a standard practice to test if the instruments are weak. For the PDS, the poverty status of the households and the number of dependent members (e.g., children, elderly without old-age pension) in the family were used as instruments. For the debt stock, presence of land titles and land size were used as instruments. The Wald test statistics below suggest that the null hypothesis, that the instruments are weak, can be rejected for both the PDS and the debt stock. The correlation matrix in the Appendix does not raise any cause for concern.

Hypothesis	Test statistics	
	PDS rice (kg)	Household Debt Stock (log, INR)
H0: variables are exogenous		
Wu-Hausman F(1, 928)	0.577	0.510
Durbin Score chi2 (1)	0.578	0.532
H0: instruments are weak (*)		
10%	19.93	22.30
15%	11.59	12.83
20%	8.75	9.54
25%	7.25	7.80

(*) 2SLS Size of nominal 5% Wald Test

Having established the lack of endogeneity between the PDS, FIS and debt stock, and lack of strong correlation amongst other variables, we moved to the second stage and estimated regression equations using an Ordered Logit Model, using the categorical FIS variable. This is a suitable model for latent variables, which are unobservable but their thresholds are known.

$y_i^* = x_i'\beta + u_i$

$y_i = j$ if $\alpha_{j-1} < y^* < \alpha_j$

where α reflects j number of thresholds or alternatives. The probability that i^{th} unit of observation will belong to j threshold is:

$P_{ij} = P(y_i = j) = p(\alpha_{j-1} < y^* < \alpha_j) = F(\alpha_j - x_i'\beta) - F(\alpha_{j-1} - x_i'\beta)$

The regression estimations were carried out using STATA and the results are reported in the next section.

4. The Results

The results with respect to state of food security in the villages covered in this study are depicted in Figure 1a. This provides two sets of information. First, the figures in the brackets next to each food insecurity (FIS) indicator on the left-hand-side reflect the incidence with which each FIS form is experienced. For example, around one in four households indicated that their diet is not nutritious and diverse because of lack of means. Around 22 percent of households indicated vulnerability to food insecurity as reflected by worries that they may run out of food. A similar proportion skipped a meal a day to remain within their means. Given the protection offered by the PDS, the proportion of those who actually run out of food or went without eating a whole day (reflecting an experience of hunger) because of lack of means is considerably high (13 and 17%). Additional questions in the survey revealed that a large number of participants viewed the PDS favourably, e.g. 84 percent said they were able to obtain 'the rations' fully and 43 percent said they would suffer from hunger without the rations.

The second set of information are depicted in the bars of Figure 1a, providing a snapshot of the degree of household FIS experience in low to moderate FIS (occasionally to sometimes) and high FIS (every week to everyday) categories. More specifically, households with FIS scores of 1-14 were classified as low to moderate FIS households. Those with a FIS score of 15 and above were classified as high FIS. The results show that vulnerability to hunger (reflected by running out of food, worrying about running out of food and not eating for a whole day) is experienced at low to moderate levels (occasionally or sometimes) but by a large proportion of households (over 80 per cent). In comparison, a greater proportion of households experienced high FIS with respect to lack of food diversity and low nutritional quality.

The next diagram (Figure 1b) reflects the incidence of FIS, experienced in combination of its different dimensions. This shows that many households suffered from multiple forms of food insecurity.

Figure 1a. Forms of household (HH) food insecurity (FIS)

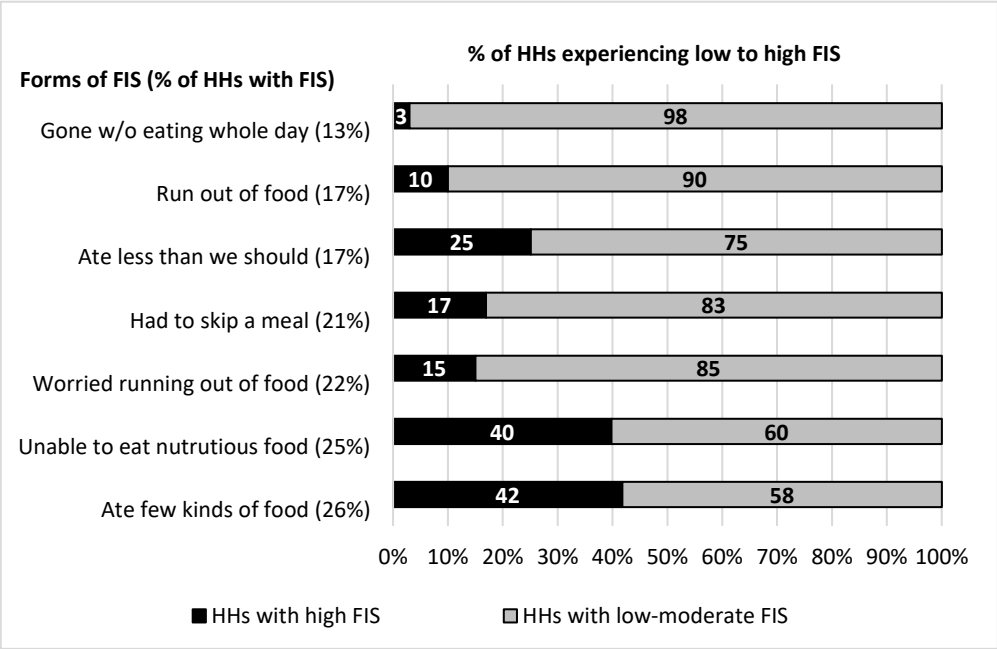
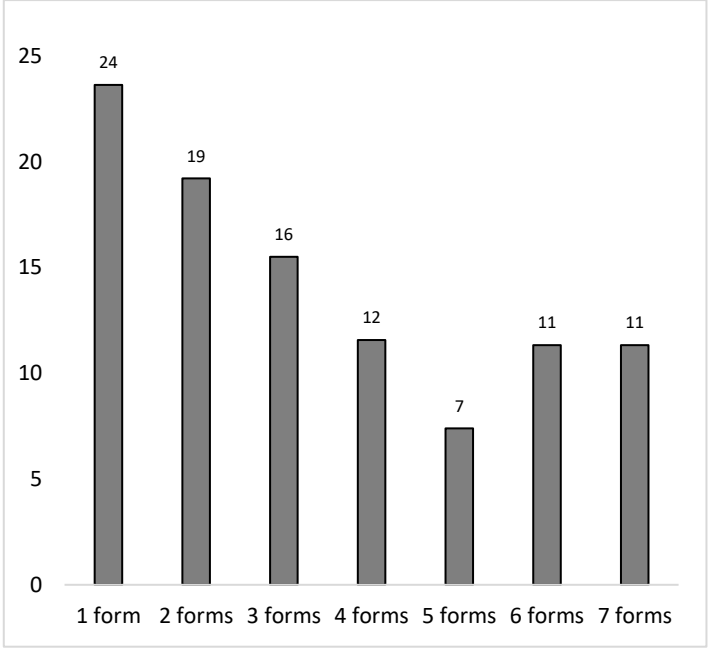


Figure 1b. Incidence of multiple forms of FIS (% of food insecure population)



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The regression results on the relationship between food security and tenure security are presented in Table 2 in two sets. The estimates in the first three columns are for all households, where the probability of food insecurity is compared between landless (base class) and landed households. The estimates in the last three columns are for landed households where the influences of three different levels of tenure security are compared against access to land without any tenure (i.e. informal access to land with or without permission). Landed households are classified into three groups: those with up to 1 acre, 1 to 5 acres, and more than 5 acres of land. For each set, the estimations are replicated, using three different FIS indicators (described in the previous section) as a measure of robustness*:* a) the composite FIS indicator, incorporating all dimensions of food insecurity; b) FIS based on nutritional insecurity and c) FIS experienced in the form of hunger.

It is clear from the estimates in the first three columns that, all things being equal, access to land has a significant relationship with food insecurity only if the land size is greater than 1 acre. For those with two to five acres, the odds of being in a food-insecure household group is 34 percent lower when food insecurity is measured to reflect nutritional deficiency and 46 percent lower when it is measured by hunger. Households with more than five acres of land have 80 percent higher probability of being food secure or being in a lower FIS class for both groups. Considering different FIS categories, if small holders with moderate nutritional insecurity (FIS:2) lose their landholding, the odds of them moving to the highest food insecurity level is 34 percent.

The influence of different forms of tenure are presented in the last three columns. The estimates reflect the probability of food insecurity for three types of tenure in comparison to informal access to land without tenure. Accordingly, being a tenant and paying rent for access to land increases the probability of food insecurity and this affect is statistically significant when FIS is measured by hunger. Access to land with land titles as well as through customary tenure is associated with lower likelihood of food insecurity and these relationships are significant for all categories of food insecurity. For example, households with customary or legal tenure are between 30 to 54 percent less likely to experience hunger. Higher land size continues to have a negative relationship with FIS.

Table 2. Odds ratios from Ordered Logit regressions – Dependent Variable: FIS (0-3)

	FIS overall	FIS nutrition	FIS hunger	FIS overall	FIS nutrition	FIS hunger
Land size	All households Base: landless			Landed Households Base: 0.1 to 1 acre		
Less than 1 acre	1.04	1.12	1			
	-0.22	-1.06	-0.02			
2-5 acres	0.6	0.66	0.54	0.58	0.59	0.52
	(-2.56)*	(-5.93)*	(-8.05)*	(-5.15)*	(-6.86)*	(-4.06)*
5>acres	0.26	0.2	0.19	0.25	0.18	0.24
	(-2.46)*	(-5.52)*	(-2.20)*	(-4.54)*	(-7.36)*	(-2.62)*
Tenure				(Base: Informal access)		
Tenant				1.11	1.02	2.5
				(-0.36)	(-0.14)	(9.03)*
Customary tenure				0.29	0.22	0.46
				(-8.52)*	(-10.9)*	(-2.12)*
Formal tenure with land title				0.57	0.51	0.70
				(-5.75)*	(-2.68)*	(-3.73)*
Credit (debt)	1.15	1.24	1.08	1.16	1.27	1.11
	(8.23)*	(4.49)*	(9.02)*	(6.26)*	(5.11)*	(4.96)*
Income	0.95	0.94	0.88	0.82	0.91	0.73
	(-2.20)*	(-3.87)*	(-2.62)*	(-1.80)	(-2.04)*	(-2.76)*
Non-agricultural income	0.99	0.98	0.99	0.99	0.99	0.99
	(-5.67)	(-3.11)*	(-2.52)*	(-2.94)*	(-2.60)*	-0.06
Food support from PDS	0.93	0.96	0.98	0.96	1.03	0.81
	(-0.42)	(-0.33)	(-0.06)	(-0.23)	-0.26	(-0.98)
Have livestock	0.99	0.99	0.99	1	0.99	0.99
	(-1.69)	(-1.64)	(-2.58)*	(-0.41)	(-0.16)	(-0.73)
Irrigation	0.96	0.98	0.93	0.98	0.99	0.96
	(-2.44)*	(-4.18)	(-7.00)*	(-6.56)*	(-2.18)*	(-7.35)*
Tractor	0.51	0.55	0.71	0.47	0.49	0.78
	(-3.14)*	(-1.82)	(-1.94)*	(-4.53)*	(-1.19)	(-2.68)*
Number of working adults	0.99	0.99	1	0.99	0.99	0.99
	(-0.19)	(-0.55)	(-0.18)	(-1.65)	(-2.36)*	(-1.94)*
Caste	0.95	1.05	0.93	0.69	0.73	0.85
	(-3.77)*	-0.38	(-2.83)*	(-11.25)*	(-2.66)*	(-0.99)
Age	1.02	1.02	1.02	1.01	1.03	0.99
	(2.39)*	(2.20)*	(3.79)*	(2.58)*	(-1.74)	(-0.29)
Education	0.99	0.98	0.99	0.97	0.97	0.96
	(-7.87)*	(-3.22)*	(-2.94)*	(-3.93)*	(-3.22)*	(-6.28)*
Cut1	1.04	1.41	1	-0.71	0.3	-0.15
Cut2	0.6	1.99	2.67	-0.41	0.85	1.42
Cut3	0.25	3.3	4.62	1.87	2.18	1.39
Number of observations	838	838	838	515	515	515
Prob>chi2	0.00	0.00	0.00	0.00	0.00	0.00

Note: z-values in parentheses. Robust standard errors are used to deal with potential heteroscedasticity, which is common in cross sectional analysis.

Intriguingly, we find that households with greater amount of credit/debt are on average 15 percent more likely to be food insecure. The corresponding probability estimate for nutritional insecurity

is 24 percent and for hunger-based insecurity is 8 percent. This is somewhat unsurprising for the following reason. Credit is a resource for investment as discussed before, but it can also be used for non-productive household expenditures. Irrespective of how it is used, credit is debt that needs to be repaid. From a theoretical point of view a positive relationship between agricultural productivity and access to credit may be possible. As far as food security is concerned, repayment obligations associated with credit diminish income for spending on nutritional and diverse food. This is especially possible in instances where credit does not yield growth because of market or climate risks in agriculture or where households have accumulated debt with repayments outstripping growth in output.[8] Thus, the findings here show that the connections, if any, amongst credit, investment and productivity cannot necessarily be extended to food security.

The results also show that the families that belong to scheduled caste and scheduled tribes are more likely to be food insecure. Older couples have 1 to 3 percent higher probability of food insecurity, especially amongst landed households. Couples with greater years of schooling are between 1 to 4 percent less likely to be food insecure and this relationship holds for both the full sample and subsample of landed households and across different definitions of food insecurity. The greater is the share of non-agricultural income the lower is the probability of nutritional food insecurity although this affect is insignificant for hunger-based FIS. Households with higher levels of food support from the Public Distribution System have lower likelihood of food insecurity but this affect is insignificant. Families who are involved in irrigated farming are less likely to be food insecure for all indicators and this relationship is statistically significant. The negative relationship between livestock breeding and food insecurity is only significant for landed households experiencing hunger. The probability of chi-square test statistics indicates that the variables in all estimations are jointly significant.

Overall, the central findings in this study indicate that relative to access to land with no tenure, the probability of food insecurity is lower for households with customary and formalised tenure and higher for access through tenancy agreements. Importantly, the negative relationship of FIS with securer forms of land tenure is unlikely to be reflecting the credit effect given that: a) land cannot be used as collateral under customary tenure in India, and b) the results revealed a positive association between household debt stock and food insecurity. It is also important to note the

[8] 61 percent of the landed households surveyed in this study had some level of debt. Average debt to income ratio (DIR) amongst landed households was 300 percent. DIR of the 28.4 percent of indebted households exceeded the average.

finding that, all things being equal, access to land of less than one acre is not sufficient to improve the probability of food security. Beyond one acre, the odds of being in the food secure category or lower FIS category increases as land size increases.

5. Conclusions and policy implications

This article has departed from the debates on the relationship between tenure security, agricultural investment and growth and investigated the presence of a similar relationship between food security and tenure security in a case study of 18 hamlets in Tamil Nadu. The study identified around a quarter of households as food insecure due to lack of nutritious and diverse diet. To remain within their means, between 13 to 21 percent of families experienced some form of hunger either skipping meals or going without eating a whole day. A large proportion of food insecure households experienced multiple dimensions of insecurity.

Three key findings relating to the land tenure-food security nexus merit attention. First, when all landed and landless households are included in the analysis, all things being equal, access to land irrespective of the form of tenure features as an important variable for food security. However, this relationship is not significant for marginal land size smaller than one acre. In India, a large proportion of arable land is owned by small and marginal land holders following a series of land reforms after independence (Besley and Burgess, 2000; Banerjee and Iyer, 2005; Bardhan and Mookherjee, 2010). The progress in reducing concentration of land ownership was accompanied by a process in which marginal farmers became 'de facto workers' (Lerche, 2013). In the area covered in this study, around 30 percent of all households were landless. One-third of all landed households (irrespective of the nature of tenure) had access to one acre or less land. Landless and marginal land holders together accounted for around half of the surveyed population. The results of this study indicate that, devoid of alternative means of survival, these families are at significant risk of food insecurity.

Second, when estimations concentrate on landed households with a view to assess the significance of different forms of land tenure against no tenure, we find that rental tenure has an aggravating effect on food security. In contrast, land ownership with title deeds and land with customary tenure are positively associated with food security. Finally, we found a negative relationship between access to credit and food security. This implies that debt servicing and repayment obligations outweigh any investment and productivity effects of credit on food security. These results are robust to different FIS indicators.

Other social and economic characteristics are important, too. For example, households belonging to Scheduled Caste and Scheduled Tribes were found to have greater probability of being food insecure than BC and MBC households. Prospects of being in higher FIS category decline as the proportion of non-agricultural income in total income increases. Having other assets such as irrigation systems (wells and irrigation canals) improves the chances of food security. Having livestock on the other hand does not have a positive influence on food security except for landless households experiencing hunger-based FIS.

Finally, it is important to highlight the limitations of this study. Given that the survey data was obtained in a particular rural setting, these results cannot be generalized in a global manner without further research. Furthermore, the data and analysis in this paper reflect the circumstances in and around the time when the survey was conducted. Further research covering different geographies and different time periods would be useful to firmly establish the long-term relationship between tenure and food security.

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Appendix Table. Correlation Matrix

	Land size	Land title	Customary	Tenant	Informal Access	Debt	Income	Non-agric income	PDS	Live-stock	Irriga-tion	Tractor	Age	Educa-tion	Caste	Working adults
Land size	1.00															
Land title	0.44	1.00														
Customary Land	0.21	-0.25	1.00													
Land tenancy	0.11	-0.13	-0.03	1.00												
Informal Access	0.17	-0.21	-0.06	-0.03	1.00											
Debt	0.03	-0.07	0.16	0.01	0.02	1.00										
Income	0.14	0.06	0.06	0.02	0.05	-0.02	1.00									
Non-agric. income	-0.18	-0.12	-0.02	-0.06	-0.05	0.05	0.03	1.00								
PDS	-0.01	0.01	-0.02	-0.02	0.02	0.08	-0.12	0.08	1.00							
Livestock	0.21	0.15	-0.02	0.03	0.05	-0.04	0.33	-0.19	-0.01	1.00						
Irrigation	0.16	0.17	0.04	0.02	-0.08	-0.04	0.07	-0.12	-0.07	0.13	1.00					
Tractor	0.30	0.27	0.01	0.05	-0.01	-0.20	0.16	-0.16	-0.02	0.16	0.10	1.00				
Age	0.03	0.04	-0.08	0.01	-0.01	-0.13	0.16	-0.15	-0.26	0.05	0.04	0.02	1.00			
Education	0.17	0.10	0.01	0.01	0.00	0.18	-0.07	0.09	0.07	0.08	0.00	0.02	-0.41	1.00		
Caste	-0.15	-0.13	0.02	-0.06	-0.02	-0.07	-0.08	0.05	0.10	-0.18	-0.19	-0.07	0.00	-0.14	1.00	
Working adults	0.04	0.03	-0.01	0.00	-0.02	-0.12	0.19	-0.06	-0.26	0.01	0.01	0.04	0.32	-0.38	0.03	1.00

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