Forest Rights, Dietary Diversity and Nutritional Security of Tribal Communities: Evidence from India

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Abstract

This paper examines the impact of the Forest Rights Act (FRA) on the dietary diversity of India's indigenous communities (Schedule Tribes or STs). The STs have historically relied on forests for their subsistence, livelihood, and cultural identity but lacked formal rights over them. In 2008, the enactment of the FRA granted these STs access to forest land and non-timber forest products (NTFPs). We use four rounds of a large-scale consumer expenditure survey and use variation in forest cover as a proxy for the potential of the Act to employ a difference-in-differences strategy. We find that post-FRA, dietary diversity of ST households increased in areas with greater forest cover, driven by an increase in the diversity of vegetables, fruits, and oils consumed. FRA titles data further supports this claim. We document a shift in food sources from subsistence-based collection and cultivation to market purchases. Improvements in dietary diversity are pronounced in areas with larger share of moderately dense forests that provide opportunities for NTFP access and use. Suggestive evidence points to an occupational/rural structural shift towards non-agricultural employments, particularly in wholesale and retail trade, and manufacturing, potentially facilitated by improved forest resource access.

Keywords: Forest Rights, Common Pool Resources, Land Tenure, Dietary Diversity, Marginalised Communities

JEL Codes: J15, O15, Q15, Q23

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1 Introduction

Forests offer a host of socio-economic benefits, including the provision of food, medicinal plants, fuel and, clean water (Johnson et al., 2013) along with various environmental benefits (Baker and Spracklen, 2019; Spracklen et al., 2012). In India, the indigenous communities (also referred to as the schedule tribes or the STs) have historically constituted the majority of forest dwellers (Kumar and Kerr, 2012). The multifaceted role of forests is particularly significant for these tribal communities who rely on them for their subsistence and livelihood. This dependence includes the collection of non-timber forest products, fuelwood, wild plants, and bushmeat, as well as utilising forest land for cultivation and grazing.

While a well established body of literature documents gains in productivity, investment, and income from land reforms and tenure security (Besley and Burgess, 2000; Banerjee et al., 2002; Deininger and Nagarajan, 2009; Montero, 2022; Besley et al., 2016; Besley, 1995), less is known about how rights over common pool resources like forests can influence broader dimensions of welfare such as nutrition. This study examines the impact of a landmark forest land rights legislation, the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (hereafter, FRA) which granted STs rights over forest land and resources their nutritional security. In particular, we examine the impact of the FRA on the dietary diversity of tribal communities.

The absence of secure tenure rights and lack of devolution of decision making power over forests limits livelihood benefits that they offer (Sunderlin et al., 2005). STs have historically faced tenure insecurity and lacked formal rights to forests. This has deep historical roots, as both the colonial and postcolonial governments asserted control over forests, effectively nullifying the traditional rights of tribal forest dwellers to inhabit and utilise these lands. It is only in recent times that there has been a growing acknowledgment of the critical role forests play in supporting the welfare of these tribal communities and how these communities can contribute to forest conservation efforts. This has culminated into the enactment of the FRA which got

implemented in 2008.

FRA not only aims at providing tenure security, its objectives include ensuring livelihood and food security of the STs. To achieve this, the Act includes several types of rights. It includes Individual Forest Rights under which tribals can claim up to 4 hectares of forest land to live in and cultivate. The Act also provides for Community Rights which recognise the rights of the tribals to own, collect, and use minor forest produce (excluding timber) such as honey, bamboo, resin, gum, and *tendu* leaves. Given the central role that such non timber forest products (NTFPs) play in the food baskets and livelihood portfolios of forest dependent tribal households, these rights have significant implications for dietary diversity and nutritional outcomes. It also grants these communities the right to access to grazing lands and water bodies. There are also provisions for Community Forest Rights that provide these communities with the rights to manage, conserve, and sustainably use forest resources.

While forests contribute positively to nutritional security (Baudron et al., 2017; Baudron et al., 2019; Olesen et al., 2022), there exists a paradox wherein the forest dwelling tribal communities in India display poor nutritional outcomes (Bang et al., 2018; Wahi and Bhatia, 2018). It is reported that the mean intake of many food items and nutrients among STs remains systematically below the Recommended Daily Allowances (RDA)[1]. This translates into malnutrition with 48.1% of ST women and 44% of ST men being underweight (BMI$<$18.5) compared to the national average of 34.8% and 34.9% respectively for women and men (National Nutrition Monitoring Bureau, 2012). In 2013-14, 42.3%, 18.7% and 36.7% of tribal children under the age of 5 years were stunted, wasted, and underweight which makes tribal children the most malnourised in comparison to other castes (Ministry of Health and Family Welfare, 2018). In this context, dietary diversity is advocated as a path for improving well being and addressing malnutrition among tribal communities (Pujari et al., 2025).

Secure rights over forest land and resources under FRA can support better dietary

[1]Intake is particularly low for vegetables, fats & oils, milk & milk products, and sugar & jaggery.

choices and food diversity. This can be attained through two pathways. One is that of direct consumption, wherein, diverse plant and animal resources[2] available in forests can be collected and consumed by STs as FRA gives them to right to access, collect, and use NTFPs. The other channel is an indirect income pathway. By granting the right to cultivate forest land, the FRA enables ST households to generate livelihood through the sale of agricultural produce. Additionally, the Act permits STs to collect, own, and sell NTFPs, providing them another important source of income. This income can be utilised to enhance nutritional well-being by purchasing diverse nutrient rich food items.

To examine the impact of FRA on the dietary diversity of the STs, we make use of multiple rounds of a large scale consumer expenditure survey from India. Specifically, we make use of the 55th (1999-2000), 61st (2004-05), and 68th (2011-12) consumer expenditure rounds, along with the household consumer expenditure survey (2022-23) conducted by the National Statistical Survey Office (NSSO) under the Ministry of Statistics and Programme Implementation (MoSPI), Government of India. We make use of a difference in differences strategy with variation in forest cover across districts as a measure of variation in exposure to the Act[3]. Thus, we compare the changes in dietary diversity of STs before and after the implementation of the Act, across areas with low versus high forest cover.

Our findings indicate that post-FRA, dietary diversity of tribal households increased in districts with greater forest coverage, that is, in regions where the potential impact of the FRA was likely to be more pronounced. The increase in overall dietary diversity is found to be driven by an increase in the number of different vegetables, fruits, and oils consumed. The findings further suggest the presence of heterogeneous effects. FRA had a more substantial impact on households where the household head was literate, likely due to the demand-driven nature of the initiative, which neces-

[2]The wild foods and wild animals from forests are nutrient dense and particularly rich in protein and micronutrients (Golden et al., 2011; Nasi et al., 2011; Powell et al., 2011; Boedecker et al., 2014; Fa et al., 2015; Cheek et al., 2023)

[3]Forest cover is positively and significantly associated with the rate of title distribution under FRA Lee and Wolf (2018)

sitates the submission of applications to secure forest rights, a process potentially more accessible to educated individuals.

We ensure the robustness of our results to state specific policy changes over time, use of alternative forest cover data and alternative periods of forest cover data, heterogeneous treatment effects, seasonality in consumption, and the development of road infrastructure. We provide suggestive evidence in favour of parallel trends. We also incorporate state level FRA titles distribution data[4] to capture the implementation intensity of FRA. This enables us to demonstrate that the impact of FRA on tribal dietary diversity is contingent on not only the Act's potential but also on its implementation intensity.

The findings also indicate a post-FRA shift in food procurement patterns, with tribal households exhibiting greater reliance on market purchases and reduced dependence on subsistence-based home production and free collection. This shift supports the presence of an income channel at work. Exploring this mechanism further, we find that the impact of FRA is concentrated in districts with larger shares of moderately dense forests which offer potential for NTFP access and use. We also provide suggestive evidence that changes in dietary diversity and food sources are linked to shifts in occupational patterns, with tribal populations moving away from subsistence-based activities towards commercialised sources of livelihood. Specifically, we observe a decline in dependence on agriculture and forestry and an increase in engagement in retail and wholesale activities, and manufacturing. This transition is likely facilitated by improved access to NTFPs following the implementation of the FRA.

The rest of the paper is organised as follows- A review of related literature is presented in Section 2. Section 3 presents the background on FRA. Section 4 presents the data and methodology. Section 5 presents the results. In Section 7, we perform a number of robustness exercises and we explore potential mechanisms in Section 8. Section 9 concludes.

[4]We rely on state level FRA titles distribution data in the absence of publically available FRA titles distribution data at a more disaggregated level.

2 Literature Review

This paper broadly contributes to the body of literature that has focused on the effects of provisioning of property rights. It has been documented that the granting of property rights leads to better investment, increase in labour supply, and reallocation of labour to market work (Besley, 1995; Field, 2005, 2007; Galiani and Schargrodsky, 2010). In the Indian context, Banerjee et al. (2002) document that agricultural tenancy reforms in West Bengal improved productivity, and Subramanian and Kumar (2024) show that encouraging farmers to obtain formal land titles increased ownership formalisation, investment, and productivity. Beyond this, Besley and Burgess (2000) found that land reforms led to poverty reduction while, Besley et al. (2016) show that tenancy reforms introduced in South Indian states lowered land inequality. Similarly, Deininger and Nagarajan (2009) found that land reforms in India promoted income growth and asset accumulation. Most of this property and land rights literature has rarely focused on welfare and human capital formation[5], particularly from a health and nutrition perspective, which is where our study aims at making a contribution.

Our study more closely relates to the body of work that has evaluated the granting of forest rights to local communities. Much of this literature has examined the participation of indigenous communities in forest management, with a focus on environmental outcomes. A number of studies have focused on Latin American countries and found positive environmental impacts (Baragwanath and Bayi, 2020; Blackman et al., 2017; Blackman and Veit, 2018; Ellis and Porter-Bolland, 2008; Romero and Saavedra, 2021; Vélez et al., 2020; Vergara-Asenjo and Potvin, 2014) while for some other countries, no significant effects were found (BenYishay et al., 2017; Blackman and Veit, 2018; Buntaine et al., 2015). Other studies have explored similar themes in Asia and Africa and found positive environmental outcomes (Baland et al., 2010; Chankrajang, 2019; Gulzar et al., 2024; Persha et al., 2011; Walker et al., 2025; Yi, 2023; Zhou et al., 2025).

[5]Galiani and Schargrodsky (2010), Subramanian and Kumar (2024), and Deininger and Nagarajan (2009) do focus on human capital but the focus in these studies has been on education and per capita consumption.

Limited studies have examined the welfare implications of provision of forest tenure security. Most of these studies have focused on livelihood and income and reported positive impacts. (Chhatre and Agrawal, 2009; Gelo and Koch, 2014; Gelo et al., 2016; Okumu and Muchapondwa, 2020). However, some evidence suggests that these benefits do not always extend to the poor (Kumar, 2002). While this growing body of research has examined the socio-economic implications of the granting of forest rights, less attention has been paid to how such rights shape broader measures of welfare and well being, particularly the influence they exert over dietary diversity and nutritional security.

Our work is also related to interdisciplinary cross country literature that has found a positive association between proximity to forests and dietary diversity and health outcomes (Ickowitz et al., 2014; Johnson et al., 2013; Naidoo et al., 2019; Rasolofoson et al., 2018). In contrast, our study provides causal evidence from a single-country context by evaluating the impact of the FRA on the dietary diversity of tribal households. Undertaking such an exercise can offer important implications for other countries where rights over forest lands and resources are not well defined.

3 Background

3.1 Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

Forests have historically played a crucial de facto role in supporting the livelihood of the STs by providing them access to NTFPs, fuelwood, wild plants, bushmeat, and by providing land for grazing and cultivation. These forests have also played a major role in shaping the cultural identity of the STs. Historically, however, these STs have experienced limited formal rights over forest land and resources. During the colonial times, the Forest Act of 1865 and 1878 gave power to the government over the use of forests and restricted forest dwellers access to collect from forests for their personal use (Ambre Rao, 2007). Similar patterns continued post independence, as

forest governance in postcolonial India prioritised conservation of wildlife and forests. Substantial areas of forests were brought under the Wildlife Protection Act in 1972 to safeguard wildlife, but this legislation did not recognise the customary rights of the tribal communities over forests (Kumar and Kerr, 2012). Similarly, the enactment of the Forest Conservation Act of 1980 aimed at ensuring the conservation of forests by giving ultimate authority over the forests to the central government. For the tribal communities, this further constrained the collection and use of minor forest produce and limited cultivation on forest lands (Wahi and Bhatia, 2018).

The 1990s marked a shift in perspective with the introduction of the Joint Forest Management (JFM) policy which formally involved local communities in forest management and conservation[6]. Under this arrangement, communities were granted limited usufruct access to forest resources, such as the collection of certain non-timber forest products, fuelwood, or fodder, while ownership and decision-making authority over the forests remained with the forest departments. However, the JFM policy faced challenges in providing welfare benefits to the participating communities owing to challenges in its regulatory framework and implementation (Damodaran and Engel, 2003; Kumar, 2002; Sundar, 2001).

These historical developments contributed towards the mobilisation for the legal recognition of the customary rights over forest land and resources of the tribal forest dwelling communities. This culminated in the enactment of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA), which provides a range of rights over forest lands and resources to eligible communities along with providing a legal framework for recognising these rights. There are various provisions under the FRA and these include-

Individual Forest Rights (IFR): These IFRs recognize the rights of individuals belonging to STs and other traditional forest dwellers[7] to claim up to 4 hectares of

[6]However, control over forests remained in the hands of the State Forest Departments

[7]Scheduled Tribes (STs) who were residing on forest lands prior to 2005 are eligible to file claims under this provision. In the case of traditional forest dwellers, they must provide evidence of residing on forest lands for at least 75 years prior to 2005 to qualify for the granting of titles.

land to live in and cultivate.

Community Rights (CR): These CRs aim at recognising the right of villagers to own, collect, and use minor forest produce (excluding timber) and the right to use grazing lands and water bodies.

Community Forest Rights (CFR): The CFRs deal with the rights to manage, protect, conserve, and govern forests within the traditional boundaries of villages.

The FRA was notified on December 31st, 2007 and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Rules, 2008, which provide for its implementation, were issued on January 1, 2008[8]. The FRA is a central legislation and under Section 14 of the Act, only the Central government has the power to frame rules to carry out the provisions of the Act.

However, the implementation of FRA is governed by both national and state level bodies. At the national level, the Ministry of Tribal Affairs is the central body which looks after implementation of the Act, formation of guidelines and orders, and addressing barriers to implementation. At the state level, state tribal welfare agencies (Tribal Development/Welfare Departments) are responsible for FRA implementation by setting up the required administrative committees and reporting progress (Lee and Wolf, 2018). State governments are not given any legislative power and are solely responsible for FRA implementation. The rights recognition process is further decentralised with the Gram Sabha (village assembly) being a key authority in the rights recognition process as title claims are filed with the Gram Sabha [9].

[8]An amendment to these rules was made in 2012. The rules in this amendment relate to community forest rights and strengthening the role of the Gram Sabha for community forest resource management. The rules also focused on addressing the issue of arbitrary rejection of claims

[9]It is important to note that while the Gram Sabha is the body where applications of claims are filed, ultimate acceptance of the application in the hands of the district level committee. The Gram Sabha reviews the application, which are then forwarded to the sub divisional level committees and the the district level committees.

3.2 FRA Implementation Across States

FRA implementation across states has varied. Some states have been pro-active in terms of FRA implementation from the start, while others picked up their performance over time.

Table A.1 presents the distribution of titles under FRA across major Indian states. The table shows that very few titles had been distributed by December 2008, only months after the notification of the FRA rules. However, by 2011, implementation started across a number of states, though the percentage of titles distributed remained low. Only some states in this period emerged as good performers, such as Odisha and Andhra Pradesh. In particular, Odisha undertook proactive implementation by undertaking training of officials and aiding the formation of FRCs. Efforts were also undertaken to create awareness on the FRA with the Act being translated into tribal languages and with the formulation of reference materials, circulars and guidelines. Andhra Pradesh government laid out a model for the phased implementation of rights recognition under FRA, with the state government making good use of GIS in demarcating individual and community areas, convening Gram Sabha for the formation of FRCs, and spreading information about FRA through handouts and banners (SCSTRTI, 2013). This year of 2011 coincides with the first post-FRA observation period in the data used for our study, lending support to the interpretation that changes in dietary diversity observed around 2011 are likely reflect the initial effects of the Actâs implementation.

By 2022, title distribution picked up substantially across states. A number of small states that had not started distributing by 2011 also report FRA title distribution by this time (for example, Goa, Uttarakhand, and Himachal Pradesh), suggesting an intensification of FRA implementation. Thus, this later period reflects the continued expansion of the granting of rights under the Act and can be viewed as a period that captures the medium to long run impact of the Act.

4 Data and Methodology

4.1 Data

We make use of the 55th (1999-200), 61st (2004-05), and the 68th (2011-12) Consumer Expenditure (CE) rounds of data, along with the Household Consumer Expenditure Survey (HCES) of 2022-23 [10] collected by NSSO under the MoSPI of the Government of India. These consumer expenditure rounds collect data on expenditure and quantities purchased of a wide range of both food and non-food items from a nationally representative sample of households. The food categories covered include cereals, cereal substitutes, pulses, milk and milk products, salt and sugar, oils, eggs, fish and meat, vegetables, fruits, and dry fruits. Along with this, information is collected on the source of the food items purchased by the household- (a)market purchase, (b) home grown, (c) free collection, (d) exchange, or (e) gift/ charity.

The analysis focuses on the rural samples of the four rounds of this consumer expenditure survey and excludes observations from Union Territories and the North Eastern states where FRA implementation has been absent.

Information on forest cover is obtained from the Forest Survey of India (FSI), under the Ministry of Environment & Forests, Government of India. We make use of the 2001 FSI report. It provides forest cover data across all districts of India where forest cover is defined as all land that is more than 1 hectare in area with tree canopy density above 10 percent. This information is collected using satellite imagery which has a resolution of 23.5m x 23.5m.

We also make use of the 2003 FSI report as it provides information on three types of forest coverage[11]- dense, moderately dense, and open. Dense forests refer to land where forest cover of trees have a canopy density of over 70 percent. Moderately

[10]The HCES is the successor of the Consumer Expenditure survey but it retains the same purpose of collecting information on household consumption and expenditure.

[11]The 2001 FSI report provides information on only two types of forest coverage- dense and open. However, it classified dense forest as forests which have a canopy coverage of 40 to 100%. This classification is argued to be too broad (Forest Survey of India, 2003).

dense forests have a canopy cover of 40-70 percent. Open forests refer to areas where the forest cover of trees have canopy density between 10 to 40 percent.

We use this forest cover data at the district level as the lowest identifiable unit in NSSO data is the district.

4.2 Variables of Interest

Dietary diversity is an indicator of the range of food available in a household and can contribute to nutritional sufficiency and food security (Hatløy et al., 1998; Ruel, 2003a; Ruel, 2003b; Kennedy et al., 2011). We calculate a dietary diversity score as our main dependent variable by counting the number of different food items purchased by a household. However, aggregating across all types of food categories masks important information regarding the type of food consumption that FRA can exert an impact on. To account for this, we also calculate separate diversity indices for the major food categories- cereals, pulses, vegetables, fruits, oil, meats, dry fruits, and milk products. Undertaking such dis-aggregation is important as different food groups contribute differently towards nutritional security[12]. It has been particularly highlighted that the consumption of fruits, vegetables, and meat is important for the prevention of micronutrient deficiencies, improvement of cognitive functioning, and physical well-being (Neumann et al., 2003; FAO and IFAD, 2012). This disaggregation thus allows us to evaluate if FRA allows STs to access more food items that are relevant from the perspective of nutritional security which these communities had previously been unable to incorporate in their diets.

While counting the variety in the consumption basket is a qualitative measure of dietary diversity, to get an understanding on the quantitative aspect, we could have looked at the quantities of different food items purchased. However, we are unable to do so due to different recall periods across the different NSSO rounds. While the 55th (1999-2000), 61st (2004-05), and the 68th (2011-12) rounds of NSSO report

[12]For example, while cereals may be a good source of macronutrients (such as calories, fats, and protein), the consumption of fruits and vegetables may be more relevant for meeting micronutrient (vitamins and minerals) needs of people.

quantities purchased and the corresponding consumer expenditure based on a 30 day recall period, the 2022-23 HCES round reports information on all food categories (with the exception of cereals and pulses) based on a seven day recall. This difference in recall makes it difficult to evaluate if FRA had a quantitative impact on the food consumption of individuals (refer to Section 10.1 of the Appendix).

Concerns regarding the difference in recall periods across rounds can also seep into our usage of a count measure of dietary diversity. Particularly, variability in consumption may be captured differently over seven days and 30 days. The different number of food items consumed generally rise with time and then ultimately plateau. Assessments of dietary diversity over very short time periods (say, one day) may result in underestimating the true variability in consumption. Prior research suggests that recall periods of at least three days may be useful in addressing such concerns (Drewnowski et al., 1997; Ruel, 2003b). Since both the recall periods used in this analysis exceed this threshold, we should be able to capture the true variability in consumption.

While these differences in recall periods may introduce some measurement noise, they are unlikely to systematically bias our results. In particular, it is unlikely that recall periods will vary in a way that is correlated with the percentage of forest cover across districts or the granting of titles under FRA. Any resulting measurement error is likely to be random and is unlikely to confound our estimates of the relationship between forest cover, FRA implementation, and dietary diversity.

4.3 Summary Statistics

A brief summary of the consumption patterns of these ST households is provided in Table 1. On average, an ST household's consumption basket is made up of around 18 food items. Pre-FRA, an ST household consumed around 16 food items while the corresponding figure post-FRA is 19 and the difference between the two is statistically significant. While on average ST households consumed around two types of cereals and two types of pulses pre-FRA, this figure significantly rises to three types of cereals

and three types of pulses post-FRA. Pre-FRA, an ST household consumed around 7 different types of vegetables while post-FRA, this consumption significantly went up to around 8 vegetables. The consumption of fruits is seen to be very low among ST households, where pre-FRA, ST households on average consumed around one type of fruit which significantly increased to around two types of fruits post-FRA. Oil consumption is the only food category where we find a significant reduction in consumption post-FRA. We also find that the variety in the consumption of meat, dry fruits and, milk and milk products also significantly goes up post FRA, albeit by a small amount.

Table A.2 in the Appendix provides some descriptive statistics on the variables used in the analysis. On average, the age of the head of the household in an ST household is around 45 years. Most of the households in our sample are headed by male heads (89.23%). Around 49% of the household heads are non-literate. The average household size of these households is around 5 members. Most of these households have marginal land holdings (60.23%). 86.54% of these households primarily rely on unclean sources of fuel for cooking.

4.4 Methodology

Our methodology depends on exploiting the considerable variation in forest cover across districts to capture differential exposure to FRA along with the nationwide implementation of the Act in 2008. Using these two sources of variation, we quantify the impact of the FRA on the dietary diversity of ST households using a difference-in-differences estimation strategy. This approach closely follows the methodology followed by Nandwani (2022) who also leverages spatial variation in forest cover to estimate the impact of the FRA. The underlying identification assumption is that the FRA is likely to have a greater effect in districts with higher forest cover, where its provisions are more relevant and its potential benefits more likely to be realised. Along with this, it has been documented that larger forest cover has been associated with higher rates of claim distribution under the FRA (Lee and Wolf, 2018), further supporting the use of forest cover as a proxy for FRA exposure.

Our empirical strategy can be defined as the following-

$$y_{idst} = \beta_0 + \beta_1 forest_d \times post_{t>2008} + \beta_2 X'_{idst} + \gamma_d + \gamma_t + e_{idst} \quad (1)$$

Here, y_{idt} is the outcome variable for household i residing in district d and state s at time t. The variable $forest_d$ is the proportion of forest cover in district d in 2001. We use forest coverage data of 2001 as forest cover of later years could be contemporaneously correlated with FRA implementation leading to an issue of endogeneity. $post_t$ is a dummy variable which takes the value 1 for years following the implementation of FRA (that is, years after 2008).

To account for household level factors that can influence dietary diversity, we incorporate X_{idt}, a vector of control variables at the household level. This includes variables such as age, sex, education level and, marital status of the household head, family size, land holding size, religion, and cooking fuel source. We also incorporate γ_d which represents the district fixed effects that absorb all time invariant district level characteristics that could influence dietary diversity. These include the socio-economic status of the district, location of the district (coastal or not), climatic conditions (temperate, arid, tropical etc.), and dietary norms. Our specification also includes γ_t which represents the round fixed effects to account for time-varying national shocks or national trends that might influence dietary diversity across all districts and households similarly. We cluster our standard errors at the district level as our treatment is defined at the district level.

We also incorporate district fixed effects,

, which absorb all time-invariant district-level characteristics that could affect dietary diversity.

Our interest lies in estimating β_1, which is the coefficient on the interaction of $forest_d$ and $post_t$. It captures the differential change in dietary diversity post FRA of individuals across low versus high forest cover.

As an alterative specification, we interact the $forest_d$ variable with the different rounds of consumer expenditure in an event study specification to get an understanding about the dynamics of the impact of FRA on food security. This can be expressed as-

$$y_{idst} = \beta_0 + \sum_{j=1}^{3} \rho_j (forest_d \times round_{jt}) + \beta_2 X'_{idst} + \gamma_d + \gamma_t + e_{idst} \tag{2}$$

Here, all variables are the same as before but now our interest lies in ρ_j which will capture how dietary diversity changes over time across areas with varying degrees of forest cover.

5 Results

5.1 Dietary Diversity

The results obtained from estimating equation (1) with dietary diversity score as the dependent variable are presented in Table 2. From column (1), we find that post-2008, if the forest cover proportion in a district goes from zero to one then the overall dietary diversity of ST households rises by approximately 2.2. Relative to the pre-intervention mean, this represents a 14.4% improvement, indicating a notable improvement in dietary diversity following FRA. In other words, this means that post-FRA, moving from a district at the 10th percentile of forest cover (5% area of the district under forest cover) to one at the 90th percentile (55% area of the district under forest cover) is associated with an increase of approximately 1.12 points in dietary diversity for ST households, relative to pre-FRA levels.

Dis-aggregating by food categories, we find that the increase in dietary diversity post-2008 is driven primarily by increased diversity in the consumption of vegetables, fruits, and oil. Column (4) shows that the most pronounced impact is observed in the case of vegetables, where diversity in the number of vegetables consumed increases by about 1.3 after moving to a district that is completely covered by forest after

2008. This corresponds to almost a 20 % increase relative to the pre-FRA mean. We also find that post-2008, if the forest cover share goes from 0 to 1 then this leads to an increase of 0.3 (36% increase) and 0.4 (40 % increase) in the dietary diversity of fruits and oils respectively.

Given that FRA is a demand driven initiative which requires individuals eligible under the Act to file claims and for the Gram Sabha to review and forward them for approval, we anticipate 2011-12 to be very close to the year of implementation to generate substantial gains in dietary diversity. Awareness of the claims process was likely to be still limited by that time. This is precisely what we observe from Panel B of Table 2 which presents the results obtained by disaggregated across rounds derived by estimating equation (2). We find that FRA generated limited gains in terms of increasing diversity in the consumption of vegetables and oils but did not significantly increase the overall diversity score. However, by 2022-23, when sufficient time had elapsed post-FRA, FRA generates a positive impact on the diversity of not only vegetables and oils but also the overall diversity measure. The dynamic effects obtained here are summarised in Figure 1.

5.2 Heterogeneous Effects

5.2.1 Education

Since rights under the FRA are not automatically conferred but require claimants to actively file claims, it is possible that individuals with higher levels of literacy are better equipped to navigate this process and successfully secure their entitlements. To assess if this holds in practice, we re-estimate equation (1) by dis-aggregating across those who are illiterate and those who are literate (possessing any level of education). These results are presented in Table 3 where Panel (A) corresponds to those who lack any education and Panel (B) corresponds to those who are educated.

Column (1) shows that the increase in overall dietary diversity among ST households is primarily driven by those who are educated. In comparison, there is no significant increase in the overall dietary diversity for those who are not educated.

For those who are not educated, we only observe an increase in the variety of vegetables consumed. In comparison, for those who are educated, we observe positive and significant increase is the variety of vegetables, fruits, oil, dry fruits, and milk products.

Table A.3 reports the results for different levels of education- primary, secondary, and higher secondary & above. We see that post-2008 with a move to an area with larger forest cover, dietary diversity increases across all levels of education.

5.3 Source of Purchase

Panel A of Table 4 presents the results obtained by estimating equation (1) with the count of the number of food items under each food category that were purchased from the market as the dependent variable. We find that post-2008, if there is a move from a district with no forest cover to one which is fully forested, the market purchase of vegetables, fruits, oil, and meat go up by 1.43, 0.42, 0.52, and 0.26 respectively.

Results for home grown produce and free collection of food items are presented in Panel B of Table 4. Post-2008, with a movement from districts with zero forest cover to full forest cover, home growing and free collection of cereals, oils and meats goes down by 0.15, 0.04 and 0.31 respectively for ST households. The only instance in which we observe a rise in home cultivation and free collection is in case of dry fruits.

The overall shift from subsistence based home cultivation and free collection to market purchases signals that following the implementation of the FRA, ST households are diversifying their diets through additional income enabled by improved tenure security. We provide further evidence on this in Section 7.

6 Robustness

6.1 Robustness to Violation of Parallel Trends

To assess the robustness of our results to violations of the parallel trends assumption, we implement the sensitivity analysis proposed by Rambachan and Roth (2023). This method allows us to evaluate how much our estimated average treatment effects would alter if districts with different shares of forest cover may have followed different underlying trends in dietary diversity even in the absence of the FRA. Following this methodology, we check the sensitivity of the treatment effects estimated to bounded deviations from parallel trends by allowing post FRA trend differences to differ from, but remain proportionally related to, the differences observed in the pre-FRA period.

When we allow potential deviations from parallel trends in the post-FRA period to be as large as those observed in the pre-FRA period[13], the estimated average treatment effects remain statistically significant. This means that even if districts with higher and lower share of forest cover would have experienced differences in dietary diversity trends after 2008 that were as large as the differences observed before the FRA, our estimated treatment effects would still remain robust. FigureA.2 shows that the magnitude of deviations from parallel trends would have to be considerably larger than what we observe in the pre-FRA period to wipe out our treatment effects.

This strengthens the causal interpretation of our findings. For the treatment effects to disappear, the districts with high and low share of forest cover would need to experience extremely large and unobserved differential trends after the FRA which would have to be much larger than any differences observed pre-FRA. Because such extreme deviations are unlikely, the analysis provides strong evidence that our estimated effects reflect the causal impact of the FRA on dietary diversity.

[13]This corresponds to setting $\bar{M}=1$

6.2 State-Time Fixed Effects

To ensure the robustness of our results, we re-estimate equation (1) by incorporating an interaction term for state and round fixed effects. This will account for all unobservable state level factors that vary over the survey rounds that our likely to confound our estimates such as state level shifts in dietary preferences, implementation of state specific food distribution programmes, and other time-varying state-level changes that may influence individuals' food choices and consumption. The results obtained are presented in Table A.4 and are consistent with those obtained earlier but smaller in magnitude. While the significance of the oil and fruits variables is lost, the vegetable variable continues to show significance. As far as the source of food is concerned, we continue to find that market purchases go up while home growing and free collection go down (except for the case of dry fruits).

A further concern could be the presence of other forest related policies that might overlap with the FRA's objectives. However, key forest programmes, such as the Joint Forest Management (JFM) initiative (1990), the National Afforestation Programme (2000), the Green India Mission (2014), and the Compensatory Afforestation Fund Act (2016), primarily focused on forest co-management or ecological restoration and afforestation funding rather than altering tribal communities' access to forest resources in a legal or redistributive manner. The inclusion of state by round fixed effects would nonetheless account for any state-specific variation in the rollout or intensity of such forest management initiatives, ensuring that the estimated effect of the FRA is not confounded by them.

6.3 Accounting Seasonality

Dietary patterns and market behaviors are subject to significant seasonal variation. As survey timing can differ across different districts, failing to control for seasonality could bias our estimates. To address this concern, we include controls for seasonality in the analysis by incorporating fixed effects for the quarter in which the survey

interviews occurred [14]. The results obtained are presented in Table A.5 and are consistent with our main results.

6.4 Infrastructure Development

An important alternative explanation for the observed increase in dietary diversity, driven by an increase in market purchases of food items post-FRA could be the expansion of infrastructure, particularly roads. Increased road development can improve market access independently of the FRA. If regions with greater forest cover also experienced differential road development during this period, the estimated FRA effect could conflate the impact of land rights with improved market connectivity.

To rule this out, we incorporate a time varying measure of road length availability at the district level by making use of road length data from International Crops Research Institute for the Semi-Arid Tropics- District Level Data (ICRISAT-DLD). We normalise the total road length in kilometers with the total area of the district and add this as a control to our main specification. The results obtained are presented in Table A.6 and they remain robust to the inclusion of this control, suggesting that the increase in dietary diversity and market purchases is not simply a consequence of improved infrastructure, but rather can be more directly attributed to the expansion of forest rights under the FRA.

6.5 Functional Form: Discrete Treatment via Forest Cover Quintiles

To examine the robustness of the main results to functional form assumptions and to explore potential heterogeneity in the effects of FRA, we re-estimate the baseline

[14]The Consumer Expenditure Surveys (CES) were traditionally conducted in four quarterly sub-rounds: July-September, October-December, January-March, and April-June. The Household Consumer Expenditure Survey (HCES) followed a more granular structure, with data collected across ten sub-rounds/panels. However, these ten sub-rounds encompass the same four core quarters used in the earlier CES rounds. To ensure consistency, we restrict the sample to households surveyed during these four standard sub-rounds in this robustness exercise which reduces the overall sample size.

specification using a discrete treatment variable based on septiles of pre-FRA forest cover. Specifically, we divide the sample into seven equal sized groups according to the baseline forest cover prior to the implementation of the FRA and interact these septile indicators with the post-FRA dummy. This approach allows us to test whether the relationship between forest cover and dietary diversity is non linear in nature and helps us to verify that the increase in dietary diversity is not driven by a few outlier districts which have very high forest cover. The results, presented in Table A.7 and Figure A.3 show that the estimated effects are negligible in the lower septiles but become larger in the upper septiles when we look at overall dietary diversity along with diversity in the consumption of vegetables, fruits, oils, dry fruits and milk products. This suggests that ST households in more densely forested regions are in a better position to benefit from improved access to forest resources and associated livelihood opportunities following the implementation of FRA.

What is also encouraging to see is that the impact is not only present in the highest (seventh) septile but also in the sixth septile and in case of overall diversity, vegetables, fruits, and milk products, the coefficients are actually larger in the sixth septile in comparison to the highest one. This suggests that the results we have obtained are not being driven by a few outlier districts with extremely high forest cover. Rather, the increase in dietary diversity is present across a broad range of high forested areas post-FRA.

This exercise also serves as a falsification test, as we do not find any increase in dietary diversity in low forest quintiles which were unlikely to have experienced significant implementation of the FRA due to limited forest presence.

6.6 Alternative Forest Cover Data and Alternative Time Periods

To ensure the robustness of our findings to alternative definitions of forest cover, we re-estimate our results using 2001 forest cover data from the SHRUG database (Asher et al., 2021; Dimiceli et al., 2015), which is obtained from the MODIS Vegetation

Continuous Fields (VCF) product. MODIS VCF is based on broad spectrum satellite imagery that assesses tree cover at a 250m resolution and is based on a machine learning algorithm that can distinguish between crops, plantations, and primary forest cover. MODIS VCF provides a continuous estimate of percent tree canopy cover for all land areas and allows us to verify that our results are not sensitive to the FSI's specific definition of forest or its minimum area threshold (1 hectare with at least 10% canopy). The results are presented in Table A.8. In line with the main results, post-2008, we find an increase in dietary diversity with a move to areas with higher forest cover which is driven by an increase in the different types of vegetables, oil and dry fruits consumed. This increase is seen to be driven by an increase in market purchases of food items and a reduction in food sourced from home growing and free collection. The persistence of our findings when using MODIS VCF, which is constructed with a different methodology and spatial resolution, provides additional confidence that the observed effects of the FRA are not artifacts of how forest cover is measured.

In addition to this, we also report results using forest cover data from 2004 and 2005, which are periods prior to the implementation of FRA[15]. The coefficients remain consistent (Table A.9 & Table A.10), suggesting that the findings are not sensitive to the choice of pre-treatment forest cover period.

6.7 Gardner's Two Stage Difference in Differences

We rely on a difference-in-differences framework for our main analysis. However, even with uniform treatment timing, standard DiD estimates can be misleading in the presence of treatment effect heterogeneity across units or over time. A substantial amount of literature attempts to address the issue of treatment effect heterogeneity in a DiD setting (Roth et al., 2023; Callaway and SantAnna, 2021). To address such concerns, we use the two-stage difference in difference methodology proposed

[15]FRA provided for tenural security to those proving their residence on forest land prior to 13th December, 2005 and provided for rehabilitation of tribals displaced without compensation prior to 13th December, 2005.

by Gardner et al. (2024). This methodology helps in ensuring that our results are robust to treatment effect heterogeneity and captures the hetrogenous treatment effects by allowing for flexibility in how treatment effect evolves over time. A key advantage of this approach is its ability to incorporate continuous treatments, which aligns with the structure of our analysis.

Table A.11-A.12 present the results obtained using this methodology. These results align with the results we obtained using the traditional DiD estimation and are also similar in magnitude. We find that post-2008, with a movement from a district with no forest cover to an area with 100 percent forest cover, overall dietary diversity goes up which is driven by an increase in the diversity in the consumption of items which fall under the categories of vegetables, fruits and oil. We again find that the increase in dietary diversity in the consumption of vegetables, fruits and oil is driven by an increase in market purchases. We observe decline in food items that are home grown or freely collected, with the exception of pulses, dry fruits, and milk, which show an increase.

6.8 Spatial Spillover

Given that forest areas tend to be geographically clustered, it is important to ensure that the results we obtain are driven by forest cover and resources present within a district and not by any spillover effect from forests in neighbouring districts.

To address this concern, we construct a variable capturing the average baseline forest cover of all neighboring districts located within 50 kilometers for each district in our sample. We interact this neighborhood forest cover variable with the post-FRA indicator and include this along with the main interaction term. The spillover coefficient captures the extent to which changes in dietary outcomes post-FRA are driven by the forest cover of nearby districts rather than the district's own forest resources. Table A.13 and A.14 present the results obtained. The results show that the spillover interaction term remains statistically insignificant across almost all the variables. This shows that the effect of FRA is not confounded by cross-district

spillovers.

6.9 Title Level Data

Till now, our identification strategy has relied on forest cover as a proxy for the potential intensity of FRA implementation under the assumption that districts with more forest cover have greater scope to benefit from the Act. To strengthen identification and better capture the actual intensity of FRA implementation, we interact forest cover with the percentage of FRA titles distributed at the state level[16]. Therefore, we now run the following equation-

$$y_{idst} = \beta_0 + \beta_1 forest_d \times titles_{st} + \beta_2 X'_{idst} + \beta_3 titles_{st} + \gamma_d + \gamma_t + e_{idst} \quad (3)$$

Here, all the variables are same as before with the addition of the $titles_{st}$ variable which captures the proportion of titles distributed relative to the total number of claims filed in state s at time t. It is important to note that this variable takes the value 0 in periods prior to 2008 and varies across state and over time in periods post-2008. We acknowledge that the $titles_{st}$ variable can be endogenous but estimating equation (3) helps us to validate our results by capturing the complementarity between the presence of forest cover/resources and title distribution.

The results obtained are presented in Table A.15. Overall, we find that post-2008, with a move to a district with high forest cover and a higher proportion of title distribution, dietary diversity of ST households goes up. Panel A shows that this improvement in diversity is driven by an increase in the variety of vegetables, fruits, oil, and dry fruits consumed. Panel B shows that there is a shift towards market based consumption with an increase the number of fruits, vegetables, oils, meats, and dry fruits purchased from the market. Panel C shows that there is a modest decline in subsistence sources of obtaining food but the magnitude of this decline is

[16]Reports are available online which provide information on FRA title distribution at the state level. Information of title distribution at the district/block/village level is not made publicly available by all states.

small. These results signal that a move from the potential benefits of the Act towards actual realisation serves to improve dietary diversity by a larger magnitude. This shows that the impact of FRA depends jointly on the availability of forest resources and the intensity of implementation of the Act.

Table A.16 reports the results for dietary diversity that are disaggregated based on titles distributed and claims filed. As expected, we find that most of the positive impact of the FRA on dietary diversity is observed for the actual distribution of titles. However, we observe that even filing for claims, without necessarily receiving titles, has some impact on improving dietary diversity. This suggests that the very process of filing may provide ST households with a sense of tenure security (perhaps driven by a reduction in the fear of eviction (Chand and Behera, 2023)), encouraging them to invest more in their diets and nutrition.

6.10 Uniform Recall Period

In this section, we restrict our sample to those rounds of data for which we have a uniform 30 day recall period. We re-estimate our main equation to quantify the impact of the implementation of FRA on dietary diversity using data from 1999-2000, 2004-05, and 2011-12. While 2011-12 is too close to the implementation of the FRA for us to be capturing any substantial impact, Table A.17 does capture some modest increase in the dietary diversity of ST households post-FRA in this short run. The increase appears to be concentrated in the consumption of diverse varieties of vegetables and oils.

6.11 Shannon Index

As a robustness test, we also measure diversity in food consumption using the Shannon diversity index, which is commonly used as a measure of nutritional diversity (Remans et al., 2014). Unlike a simple count measure of dietary diversity, this index not only captures variety in consumption of different food groups, but it also ac-

counts for how consumption is spread across different food groups [17]. The Shannon index is calculated as-

$$Shannon_h = -\sum_{i=1}^{n} p_{ih} \ln(p_{ih}), \tag{4}$$

In this, p_{ih} measures the share of consumption of household h that comes from food group i. Higher values of the index indicate greater dietary diversity, reflecting diets that are more balanced across different food categories.

From Table A.18, we see that even when we use the Shannon index, dietary diversity increases significantly in the post-FRA period in areas with larger forest cover, which is consistent with our main findings. This suggests that FRA not only increased the number of food groups consumed but it also led to a balanced allocation of consumption across them.

6.12 Per Capita Cereal and Pulses Availability/Consumption

Till now our analysis has focused on dietary diversity score without focusing on the quantities of different food items consumed. In NSSO data, cereals, pulses, sugar, salt are three food categories which are uniformly based on a uniform 30 day recall period across the four rounds of data. We now evaluate how the FRA affects the per capita availability/consumption of these cereals, pulses, sugar, and salt. From Table A.19 we see that post-FRA, with a movement from a district with no forest cover to one that is fully forested, the per capital availability/consumption of wheat and rice goes down, while that of coarse cereals such as jowar, bajra, maize, and barley goes up. It is important to note here that coarse cereals are traditionally a part of tribal diets and are richer in diverse nutrients. The observed increase therefore reflects a shift towards more locally appropriate and nutritionally superior food items, consistent with access to forests and forest resources post-FRA.

[17] It gives a lower score in case the food basket is dominated by a single food group

This is also in line with the long-standing criticism of the Public Distribution System (PDS) in India, which had disproportionately prioritised the subsidised distribution of wheat and rice, thereby undermining indigenous food items (Pingali et al., 2017). This decrease in consumption of rice and wheat can be viewed as a sign of traditional food items that are culturally relevant being prioritised.

We also observe a rise in the consumption of pulses like gram, moong, and arhar. These are important sources of plant based protein, the increased consumption of which again highlights an improvement in nutritional quality among tribal communities. Post-FRA, there is also a significant increase in the consumption of sugar and honey. The consumption of sugar among tribal communities has remained systematically below the RDA (Bang et al., 2018), given which this increase in the consumption of sugar and honey is again a positive sign of energy sufficiency.

7 Testing for the Income Channel

7.1 Type of Forest Cover- Open/ Moderately Dense/ Dense Forests

Open, dense, and moderately dense forests may impact the dietary diversity of households differently due to differences in their ecological characteristics and accessibility. Dense forests, characterized by thicker canopy cover, provide a range of biological ecosystem services (such as, carbon sequestration, climate regulation, water flow regulation, and soil protection among others) but may fall under protected zones which may limit accessibility for local communities, potentially constraining their direct use for food procurement and other subsistence activities. In comparison, open forests are likely to have less dense tree canopy but are likely to not be rich in forest resources due to degradation. In contrast, moderately dense forests are likely to have sufficiently thick canopy cover to offer diverse forest resources and are likely to be accessible and offer potential for community usage under FRA. This can facilitate the collection of fuelwood, and small-scale commercial activities, potentially influencing

household dietary patterns.

We re-estimate our main specification using the proportion of district area under dense, moderately dense, and open forest forests interacted with the post variable. This estimation can be expressed as-

$$y_{idst} = \beta_0 + \beta_1(denseforest_d \times post_{t>2008}) + \beta_2(moddenseforest_d \times post_{t>2008}) + \beta_3(openforest_d \times post_{t>2008}) + \beta_4 X'_{idst} + \gamma_d + \gamma_t + e_{idst} \quad (5)$$

Here, $denseforest_d$, $moddenseforest_d$, and $openforest_d$ represent the baseline proportion of total area under dense, moderately dense, and open forests. The omitted category is the share of land that is not forested. All the other notations are the same as before.

Estimating equation (4), from Table 5 we find that post-FRA with a movement from a district with no moderately dense forest to one that is completely under moderately dense forest, the dietary diversity of ST households goes up, which is driven by an increase in consumption of cereals, vegetables, fruits, meats, and milk products. Table 6 shows the sources of food purchase across the different types of forests. We see that an increase in moderately dense forests is associated with an increase in reliance on the market to purchase diverse varieties of cereals, vegetables, fruits, and meat products.

The increase in dietary diversity post-FRA accompanied by an increased reliance on market purchases is driven by the presence of moderately dense forests. These areas were more likely to be under active but insecure use by tribal communities prior to the Act, and thus stood to benefit more from formal recognition of rights. Moreover, these forests typically offer greater opportunities for both land use and access to NTFPs such as fruits, tubers, and fuelwood, which serve as important components of local diets and livelihoods. Thus, we find some evidence of an indirect income channel at work which is driven by improved resource access.

7.2 Occupational Movement

Given that increase in dietary diversity post-FRA is driven by larger market purchases and concentrated in moderately dense areas, we now examine the income sources of ST households. NSSO provides information on household type which is categorised based on the primary source of income of the household. Based on the four rounds of NSSO data we have used for the analysis, we can identify four household types- self employed in agriculture, self employed in non-agriculture, agricultural labourers, and non-agricultural labourers. We re-estimate equations (1) and (2) using a categorical variable that captures the primary income source of the household. The results obtained are presented in Table 7. From Panel A, we find that post-2008, with a movement from a district with no forest cover to a district with full forest cover, ST households were around 12 percentage points more likely to be self employed in non agricultural sources of livelihood. We also observe that post-2008, ST households were less likely to be self employed in agriculture. This increase in self-employment in non-agriculture and reduction in self employment in agriculture suggests that ST households are undergoing a shift from subsistence cultivation. Dis-aggregating by type of forest cover, we find that the the likelihood of being self employed in non-agriculture goes up in districts with larger share of all types of forests, showing a shift towards non-agricultural employments.

To get a better understanding of the type of activities that ST households are turning towards post-FRA, we now evaluate the industries in which they report being engaged by making use of the National Industrial Classification (NIC) codes provided in the NSS dataset for these households. Here again, we re-estimate our main equation(s) but with dummy variables capturing the NIC code that the household's primary occupation falls into as the dependent variable. These results are presented in Table 8. We find that there is no increase in the participation of ST households in agriculture and forestry post-FRA (if anything, the decline reported in Panel A column (1) is significant at the 15% level). We also find that ST households were not more likely to be involved in construction. However, column (4) shows us that ST households reported a greater likelihood of being engaged in retail and wholesale

activities post 2008 in areas with larger forest cover. Again, when we dis-aggregate by the type of forest cover, we find that the increase in employment in retail and wholesale is present across all types of forest cover. In case of these areas with lager open forests, we also find that ST households were more likely to be involved in manufacturing activities[18] post-FRA.

It is imperative to note that agriculture and forestry are generally subsistence activities, wherein, households consume most of what they grow or catch/collect (Sibhatu and Qaim, 2017). Whereas, retail/wholesale activities and manufacturing are non-subsistence commercialised sources of livelihoods. These activities are possible in forested areas post FRA owing to access to NTFPs, which can enable households to earn income through small-scale enterprises such as collection and processing of NTFPs, or processing of food, tobacco, etc. In such cases households can afford purchasing food from the market such as fruits and vegetables which are more likely to be nutrient dense and will contribute more to dietary diversity (Koppmair et al., 2017; Sibhatu and Qaim, 2017). This provides suggestive evidence that the FRA granted ST households greater rights to forest land and resources, supporting their engagement in these commercialised activities.

7.3 Community Engagement in Health

The inclusion of district fixed effects in the main analysis mitigates concerns that our results are confounded by national or sub-national health and nutrition initiatives. We now further strengthen our claim by examining if health, as a topic of discussion, gained more prominence in Gram Sabha [19] level meetings post-FRA. We do this to ensure that village level collective initiatives or deliberations around health were not the driving force behind improved diets post 2008.

For this, we make use of the Socio-Economic Profiles of Rural Households in India

[18] Under manufacturing, the type of activities we look at include those related to food, beverages, tobacco, textile, wearing apparel, leather, wood and paper.

[19] A Gram Sabha is the village assembly comprising all adultsâindividuals aged 18 and overâwhose names appear on the voter registration list.

(SEPRI) data of 2014-15. We focus on the village level survey where information was collected retrospectively about the issues discussed in Gram Sabha meetings and the frequently with which these issues were raised. We estimate the following equation-

$$y_{vdst} = \beta_0 + \beta_1 forest_d \times post_{t>2008} + \gamma_v + \gamma_t + e_{vdst} \tag{6}$$

Here, y_{vdst} captures the frequency at which the Gram Sabha for village v, in district and state d and s, deliberated on the issue of health in year t. γ_v is the village fixed effect. The other notations are the same as before.

Table A.20 summarises the results obtained where we see that villages in district with larger forest cover were not more likely to discuss the issue of health in their Gram Sabha meetings post-2008 in comparison to their counterparts in less densely forested districts. Thus, the increase in dietary diversity post-FRA is more likely to result from the indirect income/resource access channel discussed before rather than from enhanced community-level discussions or collective actions focusing on health.

8 Conclusion

This study examines the impact of the FRA on the dietary diversity of tribal communities. Tribal communities have historically maintained a highly symbiotic and interdependent relationship with forests because they depend on these ecosystems for their cultural identity, sustenance, and livelihood. However, during the colonial and postcolonial periods, forests were brought under formal state control. In this process, tribal communities faced reduced access forest land and resources, including the use of forests for residence, collection of forest products and cultivation. The FRA was introduced for the formal recognition of the rights of these communities by granting them de jure rights over forest land and forest resources. The Act formally recognises the rights of tribal communities to secure and enhance their livelihood by using the forests for occupation, cultivation, and by providing the right to collect, own and use NTFPs.

Utilising four rounds of large-scale consumer expenditure surveys and a difference-in-differences approach, this paper finds that dietary diversity among ST households increased post-FRA in districts with higher forest cover. The improvement is driven by a greater consumption of vegetables, fruits, and oils. The effect is stronger among households with educated heads, reflecting the demand-driven nature of the FRA, which requires formal claim filing.

We find post-FRA there is an increased dependence on market purchases and reduced reliance on subsistence-based food sources (that is, own cultivation and free collection). The increase in dietary diversity through market purchases is driven mostly by districts that have larger shares of moderately dense forests, which are generally rich in forest resources and have the potential for access and use under FRA. This signals that an indirect income channel is at work. To investigate this mechanism further, we examine the employment patterns of ST households. The findings indicate that, post-2008, ST households in districts with greater forest cover are more likely to be engaged in self-employment in non-agricultural activities, particularly retail and wholesale trade, and manufacturing. This provides suggestive evidence that the FRA may have reduced reliance on subsistence form of cultivation by facilitating access to NTFPs, which ST households utilise for commercialised income generation and diverse food purchases from the market.

Our results have broader implications for property rights recognition. We find that FRA improves dietary diversity through strengthened rights over natural resources which enhances income earning opportunities rather than through any nutrition based interventions. This underscores the importance of secure property rights in improving welfare and well-being. When marginalised communities are able to access, use, and benefit from forest resources, well defined property rights can facilitate a transition away from subsistence dependence, increase market participation, and support rural structural transformation.

The findings of this study have implications for policy makers in other countries where rights over resources remain contested or poorly defined. Strengthening property rights can generate substantial welfare gains that extend beyond tenure security and

increase in productivity. Well defined property rights can play a foundational role in empowering historically marginalised communities, enhancing their well-being, and fostering more inclusive development.

9 Tables and Figures

Table 1: **Summary Statistics: Difference in Food Consumption and Sources of Food Before and After FRA**

	(1) Overall	(2) Pre-FRA	(3) Post-FRA	(4) Difference (2)-(3)	(5) t-value
Dietary Diversity					
Overall Dietary Diversity	17.71	15.50	19.22	-3.71***	-60.07
Cereals	2.72	2.24	3.05	-0.81***	-56.09
Pulses	2.95	2.30	3.40	-1.10***	-61.31
Vegetables	7.35	6.80	7.73	-0.93***	-36.61
Fruits	1.26	0.94	1.49	-0.55***	-43.91
Oil	0.74	1.06	0.52	0.54***	104.73
Meat	1.37	1.35	1.39	-0.05***	-3.69
Dry Fruits	0.47	0.21	0.66	-0.45***	-54.47
Milk and Milk Products	0.84	0.61	0.99	-0.38***	-46.64
Source: Market Purchase					
Cereals		1.40	2.18	-0.78***	-48.96
Pulses		1.90	3.11	-1.21***	-65.21
Vegetables		5.80	7.05	-1.25***	-44.53
Fruits		0.81	1.26	-0.46***	-37.47
Oil		1.03	0.48	0.54***	103.02
Meat		1.00	1.24	-0.25***	-21.10
Dry Fruits		0.19	0.63	-0.44***	-54.42
Milk and Milk Products		0.37	0.78	-0.41***	-50.67
Source: Home Grown and Free Collection					
Cereals		0.59	0.42	0.17***	20.87
Pulses		0.36	0.26	0.09***	10.58
Vegetables		0.84	0.67	0.17***	11.36
Fruits		0.19	0.22	-0.03***	-4.37
Oil		0.03	0.01	0.01***	8.08
Meat		0.30	0.13	0.17***	29.49
Dry Fruits		0.02	0.02	0.00**	-2.28
Milk Products		0.23	0.20	0.02***	4.76

Table 2: **Impact of FRA on Dietary Diversity**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Panel A: Aggregated Impact									
Post×Forest	2.231**	0.033	-0.080	1.348***	0.336*	0.425***	-0.122	0.164	0.125
	(0.943)	(0.218)	(0.219)	(0.322)	(0.197)	(0.152)	(0.214)	(0.136)	(0.104)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.465	0.427	0.477	0.374	0.244	0.527	0.450	0.422	0.397
Panel B: Dynamic Impact									
2004-05×Forest	-2.458**	0.075	-0.405	-0.567	-0.594**	-0.086	-0.364*	-0.328***	-0.188*
	(0.986)	(0.281)	(0.293)	(0.416)	(0.231)	(0.098)	(0.188)	(0.101)	(0.106)
2011-12×Forest	-1.507	-0.415	-0.655**	0.626*	-0.341	0.338**	-0.381	-0.481***	-0.199
	(1.082)	(0.276)	(0.273)	(0.374)	(0.240)	(0.142)	(0.286)	(0.127)	(0.131)
2022-23×Forest	2.125	0.336	-0.119	1.248***	0.191	0.399**	-0.295	0.228	0.138
	(1.344)	(0.337)	(0.327)	(0.431)	(0.276)	(0.183)	(0.296)	(0.206)	(0.146)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.468	0.429	0.478	0.374	0.246	0.527	0.451	0.427	0.398
Baseline Mean	15.50	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Figure 1: Impact of FRA on Dietary Diversity

Table 3: **Impact of FRA on Dietary Diversity: Education**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Panel A: Not Educated									
Post×Forest	1.353	-0.064	-0.435	1.469***	0.304	0.202	-0.138	-0.078	0.093
	(1.131)	(0.247)	(0.292)	(0.386)	(0.247)	(0.170)	(0.173)	(0.152)	(0.129)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,845	15,845	15,845	15,845	15,845	15,845	15,845	15,845	15,845
R-squared	0.466	0.464	0.495	0.346	0.269	0.557	0.396	0.444	0.446
Baseline Mean	14.60	2.16	2.22	6.49	0.79	1.05	1.20	0.18	0.51
Panel B: Educated									
Post×Forest	3.105***	0.121	0.158	1.398***	0.398*	0.542***	-0.053	0.336**	0.205*
	(1.103)	(0.262)	(0.204)	(0.384)	(0.238)	(0.146)	(0.254)	(0.134)	(0.120)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,711	16,711	16,711	16,711	16,711	16,711	16,711	16,711	16,711
R-squared	0.460	0.413	0.480	0.403	0.221	0.525	0.493	0.419	0.355
Baseline Mean	16.72	2.35	2.40	7.21	1.14	1.08	1.54	0.25	0.75

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table 4: **Impact of FRA on Source of Purchase**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Market Purchase								
Post×Forest	0.066	-0.152	1.429***	0.422**	0.521***	0.260**	0.109	0.057
	(0.224)	(0.197)	(0.330)	(0.186)	(0.157)	(0.131)	(0.140)	(0.107)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.360	0.423	0.338	0.241	0.514	0.369	0.417	0.308
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel B: Home Grown and Free Collection								
Post×Forest	-0.150*	0.075	-0.258	-0.115	-0.041**	-0.310**	0.057**	0.052
	(0.090)	(0.097)	(0.219)	(0.073)	(0.017)	(0.142)	(0.023)	(0.050)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.294	0.239	0.224	0.159	0.088	0.195	0.106	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table 5: **Impact of FRA on Dietary Diversity: Dense/ Moderately Dense/ Open Forests**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Post×Dense Forest	3.056	-2.191***	0.185	0.968	-2.716***	-0.215	0.349	-0.165	-1.068**
	(2.037)	(0.756)	(1.726)	(2.089)	(0.952)	(0.933)	(0.605)	(0.490)	(0.504)
Post×Moderately Dense Forest	1.814**	1.326**	0.006	3.005***	1.434***	-0.141	0.986***	0.133	0.473**
	(0.866)	(0.536)	(0.600)	(0.760)	(0.381)	(0.311)	(0.368)	(0.264)	(0.200)
Post×Open Forest	0.058	-1.798***	-0.272	-1.828*	-1.010**	1.643***	-2.092***	0.344	-0.281
	(1.092)	(0.607)	(0.760)	(0.970)	(0.467)	(0.451)	(0.580)	(0.328)	(0.361)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.338	0.430	0.477	0.375	0.248	0.533	0.453	0.423	0.398
Baseline Mean	15.50	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61

*, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level. *Post* is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading.

Table 6: **Impact of FRA on Source of Food: Dense/ Moderately Dense/ Open Forests**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Market Purchases								
Post×Dense Forest	-2.024*	0.034	3.056	-1.957*	-0.243	1.057*	-0.203	-1.049**
	(1.148)	(1.422)	(2.037)	(1.074)	(0.971)	(0.601)	(0.486)	(0.475)
Post×Moderately Dense Forest	1.077**	-0.138	1.814**	1.283***	-0.018	0.564**	0.005	0.247
	(0.461)	(0.507)	(0.866)	(0.315)	(0.299)	(0.260)	(0.248)	(0.209)
Post×Open Forest	-1.354**	-0.222	0.058	-0.664	1.684***	-0.439	0.422	-0.066
	(0.571)	(0.651)	(1.092)	(0.412)	(0.454)	(0.299)	(0.313)	(0.361)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.361	0.423	0.338	0.243	0.520	0.369	0.417	0.309
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel B: Own Cultivation and Free Collection								
Post×Dense Forest	-0.800	-0.100	-2.925***	-0.561*	-0.064	-0.696	0.039	0.014
	(0.721)	(0.443)	(1.003)	(0.292)	(0.107)	(0.502)	(0.078)	(0.212)
Post×Moderately Dense Forest	0.257	0.092	0.989*	0.164	-0.102**	0.368	0.136**	0.218**
	(0.259)	(0.304)	(0.512)	(0.181)	(0.044)	(0.282)	(0.063)	(0.099)
Post×Open Forest	-0.716**	0.099	-1.934***	-0.461*	0.084	-1.362***	-0.091	-0.263**
	(0.338)	(0.359)	(0.711)	(0.249)	(0.057)	(0.497)	(0.064)	(0.133)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.295	0.239	0.227	0.160	0.089	0.198	0.107	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

*, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level. *Post* is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading.

Table 7: **Impact of FRA on Household Type (Primary Source of Income of the Household)**

	(1)	(2)	(3)	(4)
	Self Employed		**Labourer**	
	Agriculture	**Non-Agriculture**	**Agriculture**	**Non-Agriculture**
Panel A: All Forest				
Post×Forest	-0.045+	0.119***	0.005	-0.020
	(0.060)	(0.044)	(0.054)	(0.045)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.350	0.085	0.254	0.187
Panel B: Dense Forest				
Post×Dense Forest	-0.124	0.336*	0.310	-0.387*
	(0.259)	(0.188)	(0.257)	(0.205)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.350	0.084	0.254	0.188
Panel C: Moderately Dense Forest				
Post×Moderately Dense Forest	-0.019	0.125**	-0.027	0.009
	(0.085)	(0.055)	(0.074)	(0.062)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.350	0.085	0.254	0.187
Panel D: Open Forest				
Post×Open Forest	-0.218	0.342***	0.085	-0.089
	(0.148)	(0.106)	(0.139)	(0.099)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.350	0.086	0.254	0.187
Baseline Mean	0.39	0.10	0.30	0.11

+,*, ** and *** represent significance at .15, .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level. All estimations include control variables, district fixed effects, and round fixed effects *Post* is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests.

Table 8: **Impact of FRA on Types of Employment (NIC Codes)**

	(1)	(2)	(3)	(4)
	Agriculture & Forestry	**Manufacturing**	**Construction**	**Retail & Wholesale**
Post×Forest	-0.047	0.010	0.007	0.048**
	(0.051)	(0.014)	(0.051)	(0.021)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.256	0.041	0.179	0.052
Panel B: Dense Forest				
Post×Dense Forest	0.091	0.004	-0.129	0.266***
	(0.222)	(0.068)	(0.174)	(0.088)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.256	0.041	0.179	0.052
Panel C: Moderately Dense Forest				
Post×Moderately Dense Forest	-0.052	-0.007	0.036	0.044+
	(0.070)	(0.021)	(0.079)	(0.028)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.256	0.041	0.179	0.052
Panel D: Open Forest				
Post×Open Forest	-0.157	0.085***	0.031	0.130**
	(0.119)	(0.029)	(0.124)	(0.054)
Controls	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571
R-squared	0.256	0.041	0.179	0.052
Baseline Mean	0.70	0.03	0.06	0.04

+,*, ** and *** represent significance at .15, .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level. *Post* is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests.

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10 Appendix

Table A.1: FRA Title Distribution Across States Over Time

State	Aug 2008	Dec 2008	2011	2022
Orissa	0	0	58	72
Andhra Pradesh	0	0	51	77
Rajasthan	0	1	47	43
Chhattisgarh	6	21	44	53
Kerala	0	0	44	60
Jharkhand	0	0	34	56
Maharashtra	0	0	31	46
Madhya Pradesh	2	3	31	47
West Bengal	0	0	20	32
Tamil Nadu	0	0	17	25
Uttar Pradesh	0	0	13	20
Gujarat	0	0	13	51
Karnataka	0	0	4	6
Bihar	0	0	1	2
Himachal Pradesh	0	0	0	5
Uttarakhand	0	0	0	3
Goa	0	0	0	2

Source: Forest Rights Act website. The figures across the columns represent the percentage of titles distributed out of the total titles that are filed for up to August 2008, December 2008, April 2011 and July 2022 respectively.

10.1 Different Rounds of NSS Data

It is important to highlight that these different consumer expenditure rounds use different recall periods for food expenditure. In particular, the 55th CE round asked the same respondents to recall food expenditure over both a seven day recall period and a 30 day recall period. This has raised concerns about the seven day recall period contaminating recall in the 30 day recall period, since the same households are being asked to report these responses. A shorter recall period results in a higher reporting of expenditure which can then result in overestimation of expenditure in the 30 day recall period. However, the official documentation of the 55th round of

NSS reports that the 30 day recall questions were administered prior to the seven day recall ones, which also reassures us about overestimation of consumption in the 30 day recall window. However, even if some bias seeps in, it is believed that the magnitude of such as upward bias is likely to be be small (Bhalla, 2003). Also, while there were two recall periods for data collection, all the reported expenditures in the data files for this round have been standardised to a 30 day reference period.

The 61st CE round of NSS collected information on food expenditure uniformly over 30 day recall period. In comparison, the 68th CE round had two schedules that were used[20], one in which food expenditure was collected for a 30 day recall period, and another where food expenditure was collected for a 7 day recall period for all categories (except pulses and cereals where a 30 day recall period was used). However, these different schedule types were administered to different sets of households which alleviates concerns about over-reporting of expenditure as with the 55th round. In comparison the 2022-23 HCES collects information on food expenditure over a 7 day recall period for all (again, excluding cereals and pulses where a 30 day recall is used).

The analysis takes the 30 day recall period for all rounds up to the HCES round of 2022-23, where we have no choice but to use the 7 day recall. However, as the analysis is based on dietary diversity scores rather than quantities or values of food consumption, it is largely insulated from these recall-period differences. The dietary diversity score captures the range of food groups consumed rather than the exact quantity or expenditures, making it less sensitive to these differences in recall periods. Still, to mitigate any remaining concerns arising from differences in recall, we present a robustness exercise which only uses the first three rounds of CE survey. We also report a robustness test that looks at the quantities of cereals and pulses as these are the to food categories that are based on a uniform recall period of 30 days across.

[20]Half the households in the sample were given one type of the schedule while the others were given the other

Table A.2: **Summary Statistics: Household Characteristics**

	(1) Pre-FRA	(2) Post-FRA	(3) Overall
Age	43	46	45
Sex: Male (%)	91.94	87.38	89.23
Sex: Female (%)	8.06	12.62	10.77
Education: Illiterate (%)	57.14	42.9	48.67
Education: Till Primary (%)	24.06	28.03	26.42
Education: Till Secondary (%)	13.57	20.73	17.83
Education: Higher Secondary & Above (%)	5.23	8.34	7.08
Religion: Hindu (%)	91.16	92.47	91.94
Religion: Muslim (%)	0.7	0.38	0.51
Religion: Others (%)	8.14	7.15	7.55
Household Size	5	5	5
Marital Status: Married (%)	85.81	83.93	84.69
Marital Status: Never Married (%)	3.37	2.15	2.64
Marital Status: Widowed/ Divorced/ Separated (%)	10.82	13.93	12.67
Land Class: Landless (%)	2.67	1.69	2.09
Land Class: Marginal (%)	62.82	58.46	60.23
Land Class: Small (%)	17.86	18.68	18.35
Land Class: Medium-Large (%)	16.64	21.16	19.33
Cooking: Unclean (%)	93.89	81.53	86.54
Cooking: Clean (%)	3.84	17.51	11.98
Cooking: Others (%)	2.27	0.95	1.49

Table A.3: **Impact of FRA on Dietary Diversity: Different Levels of Education**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Panel A: Primary									
Post×Forest	3.393***	0.356	-0.023	1.428***	0.453	0.584***	0.066	0.299**	0.230*
	(1.156)	(0.252)	(0.232)	(0.423)	(0.276)	(0.148)	(0.218)	(0.152)	(0.118)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,589	8,589	8,589	8,589	8,589	8,589	8,589	8,589	8,589
R-squared	0.495	0.464	0.509	0.433	0.244	0.544	0.502	0.442	0.385
Baseline Mean	15.80	2.24	2.28	6.89	0.98	1.05	1.49	0.20	0.67
Panel B: Secondary									
Post×Forest	2.923**	-0.120	0.295	1.341***	0.245	0.564***	-0.029	0.356**	0.272*
	(1.252)	(0.326)	(0.276)	(0.495)	(0.255)	(0.158)	(0.286)	(0.169)	(0.143)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,787	5,787	5,787	5,787	5,787	5,787	5,787	5,787	5,787
R-squared	0.454	0.403	0.484	0.406	0.219	0.534	0.504	0.453	0.363
Baseline Mean	17.37	2.44	2.48	7.43	1.24	1.10	1.61	0.27	0.80
Panel C: Higher Secondary & Above									
Post×Forest	3.073*	0.140	0.290	1.063	0.714*	0.362*	-0.209	0.465*	0.247
	(1.777)	(0.505)	(0.412)	(0.710)	(0.420)	(0.203)	(0.376)	(0.264)	(0.182)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,245	2,245	2,245	2,245	2,245	2,245	2,245	2,245	2,245
R-squared	0.447	0.413	0.512	0.429	0.266	0.597	0.572	0.436	0.391
Baseline Mean	19.26	2.65	2.74	8.12	1.58	1.17	1.64	0.39	0.98

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

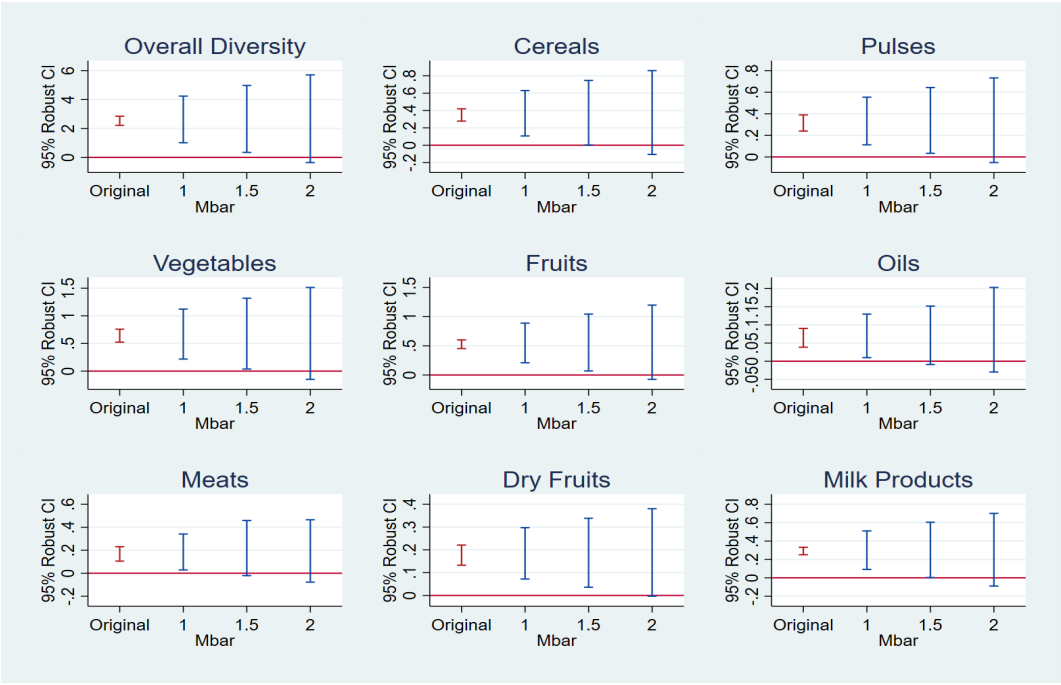

Figure A.2: Sensitivity to Deviations from Parallel Trends

Table A.4: **Impact of FRA on Dietary Diversity Using State×Round Fixed Effects**)

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Dietary Diversity								
Post×Forest	-0.207	-0.033	1.138***	-0.118	0.085	-0.278	0.153	0.102
	(0.231)	(0.276)	(0.324)	(0.203)	(0.082)	(0.212)	(0.110)	(0.119)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State×Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,570	32,570	32,570	32,570	32,570	32,570	32,570	32,570
R-squared	0.448	0.494	0.390	0.263	0.612	0.462	0.455	0.414
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Post×Forest	-0.275	-0.019	0.969**	0.076	0.155*	-0.075	0.081	0.016
	(0.243)	(0.248)	(0.383)	(0.195)	(0.087)	(0.145)	(0.113)	(0.115)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State×Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,568	32,559	32,570	32,570	32,570	32,570	32,570	32,570
R-squared	0.377	0.438	0.352	0.263	0.604	0.380	0.449	0.325
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Post×Forest	-0.025	-0.043	0.102	-0.254***	-0.038**	-0.177	0.067**	0.054
	(0.091)	(0.119)	(0.246)	(0.080)	(0.018)	(0.124)	(0.030)	(0.046)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State×Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,568	32,559	32,570	32,570	32,570	32,570	32,570	32,570
R-squared	0.312	0.251	0.250	0.173	0.098	0.215	0.115	0.237
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.5: **Impact of FRA on Dietary Diversity (Controlling for Seasonality in Consumption)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cereals	**Pulses**	**Veg**	**Fruits**	**Oil**	**Meat**	**Dry Fruits**	**Milk**
Panel A: Dietary Diversity								
Post×Forest	-0.064	-0.259	0.959***	0.243	0.410***	-0.196	0.032	0.038
	(0.238)	(0.216)	(0.319)	(0.222)	(0.150)	(0.203)	(0.111)	(0.102)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,084	24,084	24,084	24,084	24,084	24,084	24,084	24,084
R-squared	0.412	0.496	0.436	0.255	0.472	0.454	0.418	0.401
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Post×Forest	-0.065	-0.266	0.877***	0.267	0.488***	0.125	-0.011	-0.019
	(0.223)	(0.200)	(0.315)	(0.199)	(0.156)	(0.139)	(0.112)	(0.098)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,082	24,073	24,084	24,084	24,084	24,084	24,084	24,084
R-squared	0.332	0.430	0.385	0.251	0.443	0.358	0.412	0.299
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Post×Forest	-0.132	0.014	-0.028	-0.064	-0.032*	-0.247*	0.046***	0.028
	(0.100)	(0.095)	(0.208)	(0.076)	(0.017)	(0.141)	(0.017)	(0.047)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,082	24,073	24,084	24,084	24,084	24,084	24,084	24,084
R-squared	0.310	0.259	0.269	0.180	0.090	0.214	0.126	0.246
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.6: **Impact of FRA on Dietary Diversity (Controlling for Road Availability)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cereals	**Pulses**	**Veg**	**Fruits**	**Oil**	**Meat**	**Dry Fruits**	**Milk**
Panel A: Dietary Diversity								
Post×Forest	0.054	-0.165	1.633***	0.154	0.466***	-0.186	-0.061	0.054
	(0.279)	(0.260)	(0.453)	(0.229)	(0.163)	(0.273)	(0.159)	(0.119)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,568	26,568	26,568	26,568	26,568	26,568	26,568	26,568
R-squared	0.449	0.467	0.385	0.238	0.550	0.423	0.422	0.401
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Post×Forest	0.093	-0.275	1.770***	0.223	0.595***	0.269**	-0.139	-0.067
	(0.275)	(0.228)	(0.383)	(0.210)	(0.174)	(0.128)	(0.163)	(0.105)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,566	26,559	26,568	26,568	26,568	26,568	26,568	26,568
R-squared	0.377	0.418	0.356	0.239	0.538	0.322	0.418	0.307
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Post×Forest	-0.109	0.121	-0.222	-0.104	-0.054***	-0.358*	0.075**	0.106*
	(0.117)	(0.132)	(0.300)	(0.084)	(0.020)	(0.190)	(0.033)	(0.060)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,566	26,559	26,568	26,568	26,568	26,568	26,568	26,568
R-squared	0.296	0.232	0.246	0.180	0.095	0.220	0.108	0.235
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.7: **Impact of FRA on Dietary Diversity Using Discrete Measure of Forest Cover**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Post×2nd Forest Septile	0.707	0.058	-0.057	0.302	0.173	0.037	0.021	0.024	0.149
	(0.774)	(0.200)	(0.215)	(0.294)	(0.134)	(0.117)	(0.131)	(0.123)	(0.093)
Post×3rd Forest Septile	0.646	0.057	0.338	0.133	0.096	-0.047	-0.061	-0.041	0.170**
	(0.797)	(0.208)	(0.238)	(0.304)	(0.155)	(0.101)	(0.103)	(0.097)	(0.085)
Post×4th Forest Septile*t*	0.329	-0.118	0.027	0.478	0.084	0.029	-0.134	-0.069	0.033
	(0.815)	(0.180)	(0.189)	(0.334)	(0.136)	(0.099)	(0.102)	(0.082)	(0.088)
Post×5th Forest Septile	0.906	0.001	-0.160	0.814***	0.121	-0.028	0.097	-0.075	0.136
	(0.781)	(0.183)	(0.244)	(0.262)	(0.134)	(0.105)	(0.119)	(0.086)	(0.105)
Post×6th Forest Septile	2.741***	0.294	0.263	1.229***	0.406**	0.184*	0.142	0.006	0.217***
	(0.871)	(0.235)	(0.245)	(0.276)	(0.176)	(0.098)	(0.102)	(0.099)	(0.083)
Post×7th Forest Septile	1.901***	-0.016	0.080	0.924***	0.362**	0.223*	-0.028	0.158*	0.199**
	(0.683)	(0.174)	(0.178)	(0.236)	(0.141)	(0.116)	(0.111)	(0.094)	(0.078)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Forest Septile Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.469	0.429	0.480	0.378	0.247	0.531	0.453	0.424	0.399

All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

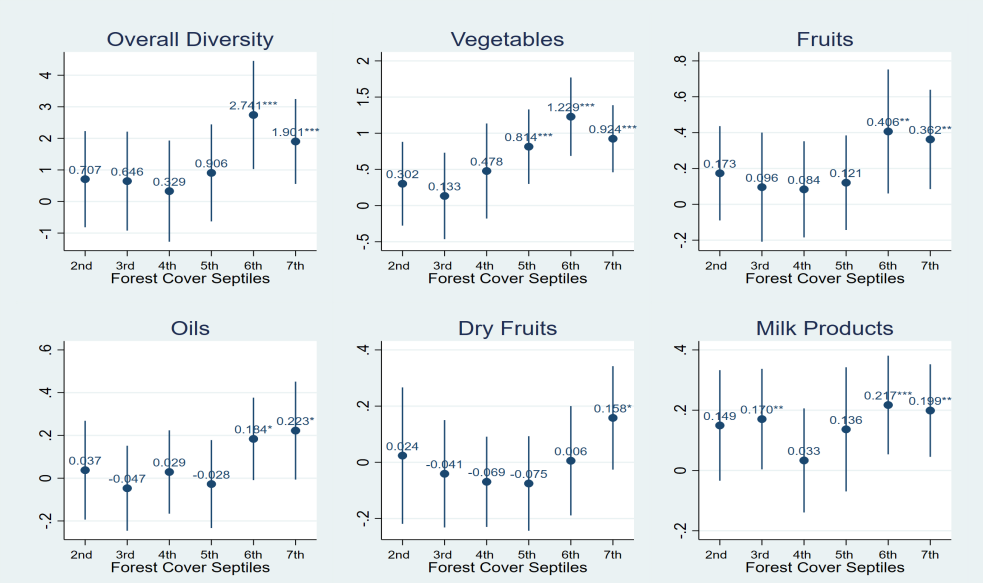

Figure A.3: Impact of FRA on Dietary Diversity by Forest Quintile

Table A.8: **Impact of FRA on Dietary Diversity Using Alternative Forest Cover Data**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Dietary Diversity								
Post×Forest	-0.277	-0.479	1.615**	0.306	1.451***	-0.594	0.475*	0.049
	(0.447)	(0.482)	(0.656)	(0.372)	(0.221)	(0.507)	(0.255)	(0.241)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.427	0.477	0.372	0.244	0.536	0.451	0.423	0.397
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Post×Forest	0.055	-0.862*	3.118***	0.585	1.608***	0.641**	0.461*	0.126
	(0.446)	(0.493)	(0.758)	(0.360)	(0.225)	(0.306)	(0.260)	(0.238)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.360	0.423	0.338	0.240	0.523	0.369	0.417	0.308
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Post×Forest	-0.436***	0.425***	-1.638***	-0.211	-0.042	-0.935***	0.034	-0.073
	(0.165)	(0.141)	(0.404)	(0.149)	(0.029)	(0.275)	(0.021)	(0.096)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.294	0.239	0.227	0.159	0.088	0.198	0.105	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.9: **Impact of FRA on Dietary Diversity Using Alternative Forest Cover Data from 2004**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Dietary Diversity								
Post×Forest	-0.386	-0.265	1.259**	0.317	1.347***	-0.656	0.408*	0.020
	(0.375)	(0.399)	(0.565)	(0.333)	(0.199)	(0.431)	(0.229)	(0.211)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.427	0.477	0.371	0.244	0.536	0.451	0.423	0.397
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Post×Forest	-0.104	-0.609	2.617***	0.583*	1.489***	0.549**	0.404*	0.148
	(0.388)	(0.407)	(0.623)	(0.327)	(0.203)	(0.263)	(0.232)	(0.212)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.360	0.423	0.338	0.240	0.524	0.369	0.417	0.308
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Post×Forest	-0.391***	0.389***	-1.448***	-0.202	-0.027	-0.905***	0.027	-0.110
	(0.141)	(0.119)	(0.343)	(0.132)	(0.026)	(0.238)	(0.019)	(0.082)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.294	0.239	0.227	0.159	0.088	0.199	0.105	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.10: **Impact of FRA on Dietary Diversity Using Alternative Forest Cover Data from 2005**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Dietary Diversity								
Post×Forest	-0.367	-0.334	1.220**	0.287	1.422***	-0.718	0.444*	-0.003
	(0.395)	(0.430)	(0.577)	(0.355)	(0.208)	(0.455)	(0.237)	(0.225)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.427	0.477	0.371	0.244	0.536	0.451	0.423	0.397
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Post×Forest	-0.018	-0.684	2.760***	0.552	1.548***	0.598**	0.444*	0.147
	(0.408)	(0.433)	(0.682)	(0.349)	(0.211)	(0.278)	(0.240)	(0.227)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.360	0.423	0.338	0.240	0.524	0.369	0.417	0.308
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Post×Forest	-0.430***	0.395***	-1.603***	-0.220	-0.018	-0.994***	0.026	-0.123
	(0.139)	(0.124)	(0.379)	(0.135)	(0.027)	(0.242)	(0.019)	(0.085)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.294	0.239	0.227	0.159	0.088	0.199	0.105	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.11: **Impact of FRA on Dietary Diversity Using Gardner's 2 Stage DiD**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Panel A: Aggregate Impact									
Post×Forest	2.190**	-0.060	-0.228	1.557***	0.426**	0.479***	-0.089	0.078	0.028
	(0.908)	(0.229)	(0.216)	(0.343)	(0.201)	(0.158)	(0.195)	(0.131)	(0.100)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
Panel B: Dynamic Impact									
2004-05×Forest	-0.754	0.082	-0.130	-0.298	-0.097	0.000	-0.153	-0.083**	-0.074
	(0.488)	(0.166)	(0.143)	(0.216)	(0.103)	(0.019)	(0.097)	(0.034)	(0.057)
2011-12×Forest	0.448	-0.296	-0.277	0.800**	0.171	0.513***	-0.182	-0.205*	-0.077
	(1.094)	(0.263)	(0.278)	(0.345)	(0.239)	(0.131)	(0.245)	(0.111)	(0.106)
2022-23×Forest	2.573**	0.198	-0.053	1.298***	0.512**	0.358**	-0.190	0.301	0.150
	(1.200)	(0.314)	(0.293)	(0.392)	(0.255)	(0.180)	(0.226)	(0.203)	(0.140)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
Baseline Mean	15.50	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.12: **Impact of FRA on Source of Food Using Gardner's 2 Stage DiD**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Market Purchase								
Post×Forest	-0.099	-0.408*	1.383***	0.493**	0.585***	0.211	0.018	-0.052
	(0.241)	(0.214)	(0.365)	(0.192)	(0.166)	(0.136)	(0.136)	(0.103)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel B: Home Grown and Free Collection								
Post×Forest	-0.018	0.188**	-0.066	-0.082	-0.042**	-0.248**	0.062**	0.087*
	(0.086)	(0.091)	(0.222)	(0.076)	(0.020)	(0.118)	(0.024)	(0.050)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.13: **Spatial Spillover: Impact of FRA on Dietary Diversity**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Post×Forest	2.024*	-0.036	0.301	1.268**	0.168	0.281+	-0.182	0.067	0.157
	(1.205)	(0.277)	(0.310)	(0.508)	(0.246)	(0.185)	(0.278)	(0.160)	(0.127)
Post×Neighbour Forest	0.052	-0.020	-0.846*	0.354	0.356	0.221	-0.040	0.148	-0.121
	(1.573)	(0.377)	(0.455)	(0.639)	(0.331)	(0.265)	(0.266)	(0.240)	(0.170)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,222	32,222	32,222	32,222	32,222	32,222	32,222	32,222	32,222
R-squared	0.465	0.429	0.477	0.375	0.244	0.529	0.443	0.422	0.398
Baseline Mean	15.50	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. +,*, ** and *** represent significance at .15, .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.14: **Spatial Spillover: Impact of FRA on Source of Food**

	(1) **Cereals**	(2) **Pulses**	(3) **Veg**	(4) **Fruits**	(5) **Oil**	(6) **Meat**	(7) **Dry Fruits**	(8) **Milk**
Panel A: Market Purchase								
Post×Forest	-0.208	0.116	1.382***	0.321	0.417**	0.094	-0.001	0.119
	(0.270)	(0.297)	(0.497)	(0.234)	(0.208)	(0.154)	(0.160)	(0.118)
Post×Neihgbour Forest	0.451	-0.628	0.392	0.227	0.144	0.210	0.168	-0.204
	(0.401)	(0.413)	(0.747)	(0.321)	(0.276)	(0.241)	(0.242)	(0.189)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,220	32,211	32,222	32,222	32,222	32,222	32,222	32,222
R-squared	0.361	0.423	0.340	0.242	0.517	0.358	0.417	0.308
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel B: Home Grown and Free Collection								
Post×Forest	-0.083	0.150	-0.214	-0.208**	-0.053***	-0.194	0.079*	0.046
	(0.117)	(0.142)	(0.372)	(0.091)	(0.020)	(0.202)	(0.042)	(0.056)
Post×Neighbour Forest	-0.143	-0.143	-0.128	0.170	0.020	-0.283	-0.040	0.024
	(0.177)	(0.195)	(0.454)	(0.143)	(0.029)	(0.202)	(0.050)	(0.099)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,220	32,211	32,222	32,222	32,222	32,222	32,222	32,222
R-squared	0.294	0.238	0.226	0.161	0.087	0.196	0.106	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.15: **Impact of FRA on Dietary Diversity Using State Level Title Distribution Data**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cereals	**Pulses**	**Veg**	**Fruits**	**Oil**	**Meat**	**Dry Fruits**	**Milk**
Panel A: Dietary Diversity								
Titles Distributed×Forest	0.570	0.125	2.906***	0.870**	1.026***	0.079	0.743**	0.255
	(0.459)	(0.467)	(0.697)	(0.407)	(0.306)	(0.410)	(0.326)	(0.215)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.428	0.477	0.374	0.245	0.529	0.450	0.426	0.397
Baseline Mean	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61
Panel B: Source- Market Purchase								
Titles Distributed×Forest	0.695	-0.086	3.154***	1.090***	1.218***	0.797***	0.609*	0.081
	(0.487)	(0.432)	(0.822)	(0.404)	(0.313)	(0.288)	(0.337)	(0.254)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.361	0.423	0.338	0.241	0.516	0.369	0.420	0.308
Baseline Mean	1.40	1.90	5.80	0.81	1.03	1.00	0.19	0.37
Panel C: Source- Home Grown and Free Collection								
Titles Distributed×Forest	-0.260	0.228	-0.628	-0.223	-0.086**	-0.567**	0.125**	0.126
	(0.189)	(0.196)	(0.430)	(0.157)	(0.038)	(0.259)	(0.055)	(0.113)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,569	32,560	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.294	0.239	0.225	0.159	0.088	0.194	0.106	0.227
Baseline Mean	0.59	0.36	0.84	0.19	0.03	0.30	0.02	0.23

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.16: **Impact of FRA on Dietary Diversity Using State Level Titles Filed and Approved Data**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Panel A: Titles Distributed									
Titles Distributed×Forest	4.008**	-0.079	0.083	1.518***	0.531*	0.759***	0.198	0.754***	0.245
	(1.728)	(0.472)	(0.455)	(0.571)	(0.315)	(0.202)	(0.272)	(0.284)	(0.195)
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.467	0.428	0.477	0.376	0.246	0.545	0.451	0.425	0.398
Panel B: Claims Filed									
Claims Filed×Forest	1.350*	-0.330*	-0.108	0.685**	0.271**	0.431***	0.058	0.218**	0.126
	(0.718)	(0.177)	(0.210)	(0.274)	(0.138)	(0.119)	(0.146)	(0.107)	(0.080)
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.466	0.430	0.477	0.373	0.245	0.529	0.450	0.423	0.398
Baseline Mean	15.50	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61

*, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level. All estimations include control variables, district fixed effects, and round fixed effects. *Titles Approved* is obtained as titles distributed as a proportion of total baseline forest cover in state s. *Claims Filed* is obtained as claims filed as a proportion of the total baseline forest cover in state s.

Table A.17: **Impact of FRA on Dietary Diversity Using Uniform Recall Period**

	(1) **All**	(2) **Cereals**	(3) **Pulses**	(4) **Veg**	(5) **Fruits**	(6) **Oil**	(7) **Meat**	(8) **Dry Fruits**	(9) **Milk**
Post×Forest	0.251	-0.330	-0.366	0.792**	0.095	0.452***	-0.157	-0.180	-0.055
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,308	18,308	18,308	18,308	18,308	18,308	18,308	18,308	18,308
R-squared	0.498	0.388	0.498	0.444	0.267	0.336	0.460	0.399	0.401
Baseline Mean	15.50	2.24	2.30	6.80	0.94	1.06	1.35	0.21	0.61

Post is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests. *All, Cereals, Pulses, Veg, Fruits, Oil, Meat, Dry Fruits, Milk* represent the count of the different items a household reported consuming under each of the respective heading. *, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.18: **Impact of FRA on Dietary Diversity Using Shannon Dietary Diversity Index**

	(1)	(2)
	Overall Diversity	**Overall Diversity**
Post×Forest	0.108**	-
	(0.044)	
Title Distributed (%)×Forest	-	0.261***
		(0.090)
Controls	Yes	Yes
District Fixed Effects	Yes	Yes
Round Fixed Effects	Yes	Yes
Observations	32,571	32,571
R-squared	0.423	0.423
Baseline Mean	1.469	1.469

*, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.

Table A.19: **Impact of FRA on Per Capita Availability/Consumption of Cereals, Pulses, and Sugar & Salt**

Panel A: Per Capita Cereals								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wheat	**Rice**	**Jowar**	**Bajra**	**Maize**	**Barley**	**Ragi**	**Millets**
Post×Forest	-1.252***	-1.448**	1.427***	0.688***	2.454***	0.039**	0.224	-0.182
	(0.441)	(0.708)	(0.354)	(0.202)	(0.783)	(0.020)	(0.150)	(0.204)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32,571	32,571	32,571	32,571	32,571	32,571	32,571	32,571
R-squared	0.664	0.686	0.374	0.292	0.385	0.044	0.363	0.116
Baseline Mean	2.170	8.190	0.708	0.198	1.002	0.013	0.196	0.064
Panel B: Per Capita Pulses								
				(1)	(2)	(3)	(4)	(5)
				Arhar	**Moong**	**Masur**	**Gram**	**Peas**
Post×Forest				0.155***	0.042*	-0.019	0.041**	0.016
				(0.059)	(0.023)	(0.066)	(0.021)	(0.010)
Controls				Yes	Yes	Yes	Yes	Yes
District Fixed Effects				Yes	Yes	Yes	Yes	Yes
Round Fixed Effects				Yes	Yes	Yes	Yes	Yes
Observations				32,571	32,571	32,571	32,571	32,571
R-squared				0.355	0.182	0.105	0.206	0.139
Baseline Mean				0.202	0.085	0.125	0.068	0.011
Panel C: Per Capita Sugar & Salt								
					(1)	(2)	(3)	(4)
					Sugar	**Honey**	**Jaggery**	**Salt**
Post×Forest					0.148**	0.002*	-0.032	0.017
					(0.062)	(0.001)	(0.036)	(0.045)
Controls					Yes	Yes	Yes	Yes
District Fixed Effects					Yes	Yes	Yes	Yes
Round Fixed Effects					Yes	Yes	Yes	Yes
Observations					32,571	32,571	32,571	32,571
R-squared					0.415	0.025	0.177	0.052
Baseline Mean					0.508	0.000	0.072	0.339

*, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level. *Post* is a variable that takes the value 1 for years after 2008. *Forest* represents the proportion of the total area of a district that is covered by forests.

Table A.20: **Impact of FRA on Discussion on Health in Gram Sabha**

	(1)	(2)	(3)
	Discussion of the Issue of Health in Gram Sabha		
	Rarely	Frequently	Always
Post×Forest	-0.031	0.267	-0.016
	(0.033)	(0.347)	(0.124)
Village Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	1,448	1,448	1,448
R-squared	0.105	0.493	0.382

*, ** and *** represent significance at .10, .05 and .01 level respectively. Robust standard errors are reported in parentheses and are clustered at the district level.