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FARM PRODUCTION DIVERSITY, HOUSEHOLD DIETARY DIVERSITY AND WOMEN'S BMI: A STUDY OF RURAL INDIAN FARM HOUSEHOLDS

Brinda Viswanathan

MSE
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MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

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Brinda Viswanathan
Associate Professor, MadrasSchool of Economics
brinda@mse.ac.in

MADRASSCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

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Chennai 600 025
India

Phone: 2230 0304/ 2230 0307/2235 2157
Fax : 2235 4847 /2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

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This project was initiated in March 2013 and completed in February 2014 and the work mainly involved the issues related to Pillar 1 of the project dealing with issues of enabling factors that link agriculture and nutrition. The nutrition component in this project mainly focused on women's BMI using the IHDS data for 2004-05. "Farm Production Diversity, Household Dietary Diversity and Women's BMI: A Study of Rural Indian Farm Households".

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EXECUTIVE SUMMARY

Undernutrition is more widespread and persistent in South Asia including India; with higher number of undernourished in rural areas and those in agriculture. Though functionally there is ample scope for agriculture to contribute towards the improvement of undernutrition, the evidence so far in the Indian context shows weak linkages. This study probes further to understand the relevance of diversity in crop production and livestock ownership in reducing undernourishment by focusing on women's BMI in rural areas. Few studies have focused on adult nutrition outcomes in general and even fewer in the particular context of agricultural and this study is a contribution in those directions.

In the first part of the analysis we find that in rural areas of India, women in cultivator households or those who have a higher share of agricultural incomes have lower rates of undernutrition and it is the women in non-agricultural wage labour households who are worst off. To capture the specific features of agriculture the second part of the analysis focusses on farm households as opposed to all those involved with agricultural activities. The idea is to harness the diversity in farming activities that could ensure access to diverse diets and also smoothen the income earnings.

The focus of this study is on women who belong to households that cultivate at least one crop and assess the impact of production diversity both in terms of crops and livestock along with household variables that capture economic status (income and assets), dietary diversity, socio-demographic features (education, religion, caste, household size and composition), her own work status (participation in the type of economic activity), her status within the household (eating along with household members or practice of purdah), quality of basic amenities (water, sanitation, cooking fuel and electricity) and health status combined with access to health infrastructure.

The study finds that the influence of agriculture on diets/BMI is better captured in a dietary diversity model than in the BMI model. This could be because the information on agriculture and diets is at the household level while BMI is for an individual. Therefore, a two-equation model with the first equation representing dietary diversity of the household and the second equation representing women's BMI as an individual's nutritional outcome captures the complex nature of relationship between different factors that influence nutrition. A more diversified agriculture and livestock holding as well as larger proportion of sale of crops has positive influence on dietary diversity after controlling for income and wealth effects.

Using an instrumental variable quantile regression model for BMI allowing for dietary diversity to be endogenous, we find that dietary diversity positively influences women's BMI in the upper quintiles more than the lower quintiles but use of clean

drinking water and sanitation has a larger influence on lower quintiles. Women in any form of employment have lower BMI with education and women's empowerment having very limited role to play once caste, religion and state level dummy variables are included in the model. Access to formal, semi-formal and informal health care facility was interacted with reported illness which resulted in an inverse relationship between access to a better health care facility and BMI capturing the fact that those who are more ill seem to seek more professional help. The results of this study also show differential impact of these determinants of BMI across the BMI distribution using a quantile regression model for the second stage. Socio-demographic variables like caste and religion affect both the first stage dietary diversity regressions and second stage BMI regressions.

The results from this study show conclusively that diversity in farming practices do impact diversity in food intakes which in turn influence the adult women's BMI. However, for BMI, factors that facilitate nutrition absorption are equally important. The results from this study once again illustrate that there are variations across regions, social and religious groups even after controlling for economic prosperity. Hence focusing on all these components would have an overall improvement in nutritional security and nutritional status.

INTRODUCTION

The evidence on the link between agriculture and nutrition has so far been tenuous. On the one hand, undernutrition rates are severe and more widespread among those involved in agriculture. This evidence is more pronounced when the households or regions with agricultural predominance are compared with non-agriculturally dominant regions (Dahiya and Viswanathan, 2015). Countries and regions that have shown a faster economic growth caused by structural transformation from agricultural to non-agricultural activities with an accompanied shift in the pattern of employment have reduced undernutrition at a faster rate. On the other hand, studies show that whenever policies favor agriculture or regions which have sustained a high growth rate in agriculture, poverty and hence undernutrition declines at a fast pace (De Janvry and Sadoulat, 2010; Christiaensen, *et al*, 2006 and Webb and Block, 2011). When persistent undernutrition is observed among those largely dependent on agriculture then it would further reduce its productivity and the vicious circle continues.

Overall reduction in poverty is indeed a pathway to reduce undernutrition but India is a case in point where there is some disconnect. In recent times, high economic growth has resulted in reduction in poverty rates but very limited reduction in nutrition outcomes particularly among children (Menon, *et al*, 2009 and Grebmer*et al*, 2010 and 2014). One could attribute this to uneven growth across different sectors of economic activity with agriculture being one of those important sectors showing far lower and variable growth rate compared to the other sectors of economy. This would in turn affect rural areas in general and states or districts that are more dependent on agriculture in particular. However, due to very limited data over time on nutritional outcomes, it has not been possible to establish conclusively a relationship between agriculture and undernutrition or arrive at the direction and magnitude of the contribution agriculture has made towards reduction in undernutrition (Headey *et al*, 2011 and Gulati*et al*, 2010 and 2014). A second aspect of the economic growth in India is that during this period of structural transformation as share of agriculture in the country's Gross Domestic Product (GDP) declined, the share of labour force in agriculture continued to be very high so that the GDP per worker (as well as per capita) in agriculture remained low (Panagariya, 2008 and Binswanger-Mkhize, 2012). We find very limited analysis that links this last feature to the extent of undernutrition using anthropometric indicators (Vepa*et al*, 2015a and b).

Among the indicators of nutrition security, nutrition outcome indicators particularly for children based on anthropometric indicators have been the key variables for assessment. Data availability in this context indicates that the problem of undernutrition among children is more severe and persistent for a country like India. Among several factors that have been shown to affect child undernutrition a recurrent factor relates to women's status in general and mother's nutritional status in particular. In this context it would be useful to document empirical evidence that analyse women's or for that matter adult nutritional status. As such there are a limited number of studies that analyse children's nutritional status within an agricultural setting in India. But even fewer studies exist for India that relate the relevance of agriculture in general and farming in particular on women's anthropometric indicators. On the one hand, such an analysis would be useful for informed policy making as, intergenerational transmission of undernutrition is a key factor in reducing undernutrition. On the other hand, adults are involved in decision making within and outside the household including participation in economic activities and understanding their behaviors and approaches and moderating them wherever necessary would come a long way in improving nutritional status. Thus, the focus of this study is to not only understand how agriculture could play a role in explaining variations in women's BMI in India but also analyse other relevant factors that could be equally important for this. For the first time in India data on food intakes and nutrition indicators is available through a countrywide survey of households and individuals for the year 2004-05 and this studyuses this data set to carry out the analysis[1].

This paper is organized as follows: Chapter 2 summarizes the recent discussions in the pathways that link agriculture to nutrition. Chapter3 presents the empirical evidence on studies related to women's BMI in India. Chapter4 elaborates the motivation and objective of this study. Chapter5 discusses the methodology and Chapter 6 is a discussion about the nature of IHDS data used for the econometric analysis. Chapter 7 presents a preliminary analysis of the data including cross-tabulation of the covariates with women's BMI status. Chapter 8 discusses the results based on the econometric models and Chapter 9 concludes the study.

[1] At the time of finalizing this report the next wave of IHDS data set has become available and would be analyzed in due course of time.

Chapter 2

AGRICULTURE AND NUTRITION: CONCEPTUAL LINKAGES

There have been several discussions on a conceptual basis of the agriculture-nutrition linkage and the pathways through which this linkage could be better harnessed to reduce undernutrition. The first set of discussions revolves around farming households that is those who own land and are self-employed in agriculture. The recent conceptual note by Das *et.al* (2014) and Nagarajan*et. al* (2014) emphasizes a system wide approach of farming that would connect the local agro-climatic and soil conditions in order to grow a wider range of crops, alongside rearing of livestock, poultry management, fisheries and maintenance of a kitchen garden. This is referred as *farming system for nutrition* (FSN) and the first component is to ensure improved accessibility to a varied set of food items locally to improve both the quantity and quality of diets in a cost-effective manner.

Improving the nutritional status is not just about consuming healthy diets but maintaining hygienic conditions in terms of sanitation, water and cooking fuel and access to quality health care which includes both preventive and curative care. Hence, the second component of FSN approach emphasizes the need to strengthen local communities by creating awareness to improve household's nutrient intakes, hygiene and marketability of agricultural outputs. Market access would ensure increase in farm incomes and hence economic prosperity of the households. This increase in affordability combined with better access to markets would also improve access to other food and non-food requirements that the households cannot meet from the local environment and thereby also contribute towards redressing seasonal fluctuations in dietary intakes.

The third component of FSN emphasizes a key role to be played by the communities and to involve the local administration for a smooth transmission of information regarding government schemes and technology that could be used by the farming community to achieve better outcomes in a sustained manner. This local level management would need support from higher tiers of government which would set certain guidelines and policies for access to subsidized inputs (for instance) and further strengthen the awareness towards good practices in production and consumption. The role of non-governmental organisations (NGO) as intermediaries in this process cannot be undermined and once again, regulations and procedures for an effective involvement have to be laid down by the government. The role of NGOs usually shown to be effective in creating awareness towards women's empowerment, improving intra-household resource allocation, timely access to health care and government subsidies and schemes that the less privileged could take advantage of.

A second set of suggested linkage between agriculture and nutrition is more broad-based with agriculture friendly policies acting as enabling conditions and other related policies that help modify behavior towards improvement in nutritional intakes and outcomes. Pinstrup-Andersen (2013) argues that the link between agriculture and nutrition is not due to the quantum of food produced alone or with consumption from own production and its allocation within the household. Food pricing policies affect net consumers and net producers differently; agricultural incomes and access to nutrition dense food (impacting hidden hunger) could be affected by agricultural policies involving international trade; chronic or transitory food insecurity could be significantly ameliorated due to policies that improve investment in roads, irrigation and storage facilities, as well as easier and regular access to credit and local markets. Women’s nutritional status has a life-cycle effect and hence gender-sensitive policies should enable them to access resources as well as allocate her time such that care behavior and feeding practices are not affected as they are known to significantly impact children’s nutritional status.

Both these approaches stress the importance of governance as key to strengthen the agriculture-nutrition linkage. More generally that governance is key to accelerate the reduction in undernutrition is emphasized in Haddad *et al*, (2012) and Muhmand (2012) which is also applicable to the sectoral context of this study. Summarizing from these studies, governance plays a key role in facilitating: (a) horizontal coordination across sectors of the economy and departments of various ministries at the state and central level; (b) vertical communication between the different tiers of government to ensure effective service delivery; (c) engagement with civil society groups to improve accountability; and (d) collection of data periodically to monitor and evaluate the impacts.

Given this background the next chapter presents the motivation and objective of this study.

Chapter 3

MOTIVATION AND OBJECTIVE

South Asia has a large population dependent on agriculture and a significantly large proportion of them are undernourished. Added to this is poor service delivery of basic amenities and a multi-layered discrimination. Social discrimination has been observed to be more persistent in South Asia including India than in any other part of the world. There are many discriminatory practices prevalent in these regions that lead to a skewed distribution of resources between the less and the more-disadvantaged social/religious group as well as between members of a family. All of this contributes to large gaps in nutritional achievements among segments of population. Under these circumstances, direct state intervention and assisted by non-governmental intermediaries becomes essential to loosen up the persistent rigidities. Timely access to nutritious food and awareness about care practices are also known to cause severe malnutrition particularly among children. More importantly, countries like India have several food and nutritional security policies as well as agricultural and social policies to address many of these concerns. Yet, there has been limited reduction in undernutrition.

Given the ample scope for leveraging agriculture for improving nutritional outcomes in South Asia, this topic seems to have gained significant attention from policy makers and donor agencies recently. With greater emphasis being laid on evidence based policy making, more empirical evidence to understand the linkage between nutrition and agriculture becomes essential (Malhotra, 2014). This study is a contribution in this direction that attempts to focus only on the rural areas of India in trying to connect farm production diversity to dietary diversity at the household level and then linking that to women's BMI. By studying women's BMI we are also able to focus on the individual as the final unit of analysis rather than a household and also enable us to look into aspects of women's empowerment, an area of immense importance in the South Asian context.

Nutritional intakes and outcomes are both used to study undernutrition. Due to the availability of country-wide data in India for a fairly long period of time on nutritional intakes, empirical studies on trends and patterns in nutrition intakes, and the factors determining its variations have been studied more extensively (Viswanathan and Meenakshi, 2008; Sharma, 2015). A major difference between intake and outcome indicators in India is that the former is usually based on household level information while the latter is for individuals. Anthropometric indicators like height (for age), weight (for age) and Body Mass Index (BMI) are common indicators of nutritional outcomes at the individual level. As such, the data on nutrition outcomes has been available less frequently so that analysis based on changes over a long period of time are difficult to carry out in the Indian context barring a few exceptions (Bhalotra, 2007; Pathania, 2007; Deaton, 2008; Moradi and Guntupalli, 2008; Viswanathan and Sharma, 2009). Whatever data is available it is focused more on younger children than for older children, or adolescents or adults. In most of these studies exploring the role of farming in improving nutritional status has not been addressed.

Finally, the data source for nutrition intakes and outcomes are separate in India, so analyses that combine nutrition intakes and outcomes even though one is for the household and another for the individual are rare and has been possible only by aggregating into regional level comparisons (Sharma, 2015; Maitra et. al., 2013). For a large country like India, it becomes difficult to gather data on individual food intakes on a periodic basis. Hence any analysis that combines intakes and outcomes at an individual level is not possible for the country as a whole[2].

With the recent availability of information from Indian Human Development Survey (Desai, et. al, 2007) for the year 2004-05 on household level food intakes and individual level anthropometric data for 0-3 year olds, 11-13 year olds and 15-49 year old women, a few studies have analysed that connect food consumption patterns to nutrition outcomes (Kalaiselvi, 2011; Bhagowalia et. al., 2012a; Dahiya and Viswanathan, 2015). We use this database that provides information on details of crop production, livestock ownership; economic, social and demographic features; amenities available to households as well as information on access to public services; to carry out an analysis to understand the linkage between farm production diversity, household dietary diversity and BMI of adult women.

We model this using two-stage instrumental variable quantile regression model. First (stage) equation for dietary diversity (index) would capture how features of access, affordability and awareness explain its variations at the farm household level. The second (stage) equation for BMI would capture some of these features as well as environmental factors and health (care) variables. Thus, this empirical analysis captures nutritional intake at the household level and nutritional outcome at the individual level.

[2]The national nutrition monitoring bureau is the only source for data on both intakes and outcomes at an individual level but is available only for a small region of this country but is accessible in an aggregated manner rather than at the individual level which gives limited scope for analysis of this kind.

Dietary diversity or variety in food intakes using household level data is explained using crop production diversity and diversity in livestock ownership and other control variables including wealth status, income diversity and income derived from agriculture. Thus, diversification between these two main activities as well as within cultivation (in terms of varieties of crop grown) and livestock ownership (ownership of variety of animals and birds) are the important factors taken into consideration from the perspective of farming.

BMI among adult women is explained using household dietary diversity (as estimated from the first stage equation) and other factors like women's status and enabling conditions including clean environment and agricultural work carried out by women. BMI is the ratio of body weight (in kilogram) to the square of height (in meters), and is an anthropometric indicator that captures short-term nutritional status. For adults, BMI is strongly correlated with body weight rather than to height but as body weights are also related to stature so weight is normalized by (squared) height. Any adverse shock in consumption or disease environment could result in reduction of body weight and hence BMI, so it is considered as a short-term indicator of nutritional status. It is well known that both low (chronic energy deficiency) and high (overweight and obesity) levels of BMI are considered as malnourishment but of different kinds. Hence a quantile regression model is used which will help in distinguishing how different factors affecting women varies with different levels of BMI.

A large part of the analysis is carried out only for farm households in rural India and the emphasis of the study is more on explaining variations in women's BMI. This analysis is preceded by estimating binary regression models that differentiate between low BMI and others (CED or not), to compare between agriculture and non-agriculture households and between farm and non-farm households. The next chapter summarises the evidence so far on the nature of variation in women's BMI in India.

Chapter 4

VARIATIONS IN WOMEN'S BMI: EVIDENCE FROM INDIA

General Pattern

Navaneetham and Jose (2008), based on the National Family Health Survey for 2005-06 (NFHS-3), show that around 40 percent women in rural India are chronic energy deficiency (CED, henceforth) i.e. having a BMI below 18.5. This is 15 percentage points higher than the incidence among urban women[3]. About one-half of women below 20 years of age are CED while there is reduction in CED rates to one-fourth for women in 40 to 49 years of age. So there is clearly improvement in CED rates with age but the older women also shows a higher rate of overweight and more so in urban areas and among states like Tamil Nadu, and Kerala (Seshadri, 2009). Ackerson *et. al.* (2008), from an earlier round of NFHS at a more granular level of districts and villages, shows that there are clearly regional patterns. Contiguity of low BMI regions and high BMI regions and its association with regional development is an important finding of that study. The gender gap in BMI is not significant when compared to a huge gender gap in anemia at the all India level (Jose, 2012). However, the gap between male and female rural CED rates are marginally higher than urban, and is relatively higher among the lower wealth categories and among scheduled tribes when compared to other caste groups and only very few states like Bihar exhibit huge gender gaps in CED rates.

Economic Status and BMI

India is changing fast economically and socially and hence household's economic well-being and the changing status of women in society can play major role in improving women's health. Subramanian and Smith (2006) used India National Family Health Survey for 1998-99 and found that undernutrition was most prevalent among women belonging to lowest quintile of standard of living and over-nutrition was observed among top-most quintile of standard of living. As the standard of living became better, the risk of being undernourished declined with it systematically. People from higher income groups consume a diet containing 32 percent of energy from fat while people from lower income group consumed only 17 percent of their energy from fat. This partially according

[3]As for adult heights, Viswanathan and Sharma (2009) using the same data show that the agriculturally prosperous Indian states of Punjab and Haryana are the only exceptions wherein the average heights of women in rural areas is higher than that of urban areas for all cohorts of women born between 1955 and 1990.

to them explained the positive relationship between socio-economic standards and BMI of women.

According to NFHS-3, 50 percent of women from the poorest quintile suffer from CED and women belonging to disadvantaged social groups also show high rates. The highest incidence of CED is found in the eastern states, such as Bihar (45.1 percent), Jharkhand (43.4 percent), Orissa (41.7 percent) and West Bengal (39.1 percent), in India (Deaton, 2008). On the other hand, Southern states have lowest incidence of CED. Singh et.al (2012) estimates a multinomial logistic regression to capture the factors that determine low BMI (thinness), normal BMI and high BMI (obese). Women from lower economic status are more likely to be thin while obesity is prevalent among the well-off as well as more developed southern states.

Dahiya and Viswanathan (2015) find that economic status captured by three different variables: per capita income, per capita total consumption and wealth status have an influence on the women's BMI after controlling for several other variables. As explained in the next section we provide a discussion on why including each of these variables have a different meaning with regard to economic status. It is noted that magnitude of the per capita consumption variable increased with the BMI quintile while the magnitude of the per capita income variable is very similar across the BMI quintiles and the effect of wealth status is observed for higher wealth status among all the quintiles with increasing magnitudes across the BMI quintiles.

Women's Empowerment and BMI

There is significant evidence that mother's educational status directly influences her own as well as her children's nutritional and health status. Many women in developing countries cultivate, purchase and prepare much of the food eaten by their families, but they often have limited access to information about nutrition. An educated woman has better abilities for the control of physical and financial assets and is motivated to eat a healthy diet and feed their babies and children foods that meet their special nutritional requirements. Since women's status is a latent variable and is multi-dimensional in nature, most studies use proxy measures consisting of several indicators that depict sources of power such as education or age at marriage as measures of women's autonomy.

Bhagowalia et al. (2012b) find that women's empowerment, which includes her mobility, decision-making power, and attitudes toward verbal and physical abuse, is positively associated with her nutritional outcome as well as that of her children. Women's education and paid work have been shown to be associated with overall well-being of a household or a region, perhaps due to the autonomy and agency effects (Dreze and Sen, 1995; Agarwal, 1997 and Sen, 1999). Hindin (2005), in a study of malnutrition in Zimbabwe, Malawi and Zambia, suggests that women who have lower levels of autonomy and status within household are more likely to experience undernutrition. Jose (2012) finds that CED rate among women who have some autonomy in decision-making related to daily purchases, major purchases, health care, or mobility (visit to relatives/friends) is lower than those who do not have this 'luxury'. There are also regional variations in the level of such autonomy with a 10 percentage point difference in CED rates between women who have no decision making power to those who have decision making power in all the four components mentioned above. It is very likely that women with less autonomy could also be less educated or belong to more backward regions and hence constrained in other ways so that to assess the magnitude of the impact of women's autonomy on BMI, one needs to control for these other factors. Dahiya and Viswanathan (2015) estimate an index of autonomy which captures aspects of mobility, financial freedom, and her involvement in decision making. This index is then converted into quintiles of its value to capture increasing levels of autonomy. The results show that lower levels of autonomy do not make any difference to women's BMI. It is only at the highest (top quintile) level of autonomy that one observes the impact though its magnitude is nearly similar across the BMI quintiles.

Basic Infrastructure and BMI

Better and safer access to basic infrastructure like water, electricity, sanitation and cooking fuel has a direct impact on the individual's health status by preventing frequent (infectious) illnesses. Electricity in particular contributes towards reducing physical effort while carrying out day to day chores. For instance, Rao *et al*, (2008) show that collection of drinking water and fuels, which is primarily carried out by women, has considerable adverse impact on women's nutritional reserves. Government also plays a major role in providing these amenities to the people and hence these variables also imply regional effectiveness of the provisioning and maintenance of these essential public goods. Even if these amenities are available, irregular use of these amenities could be a matter of preference or the lack awareness of households towards leading a hygienic life; for instance there may be a preference for cooking with firewood in spite of LPG being available and use of open area for defecation despite having a toilet inside the house.[4]

Jose and Navaneetham (2010) show that CED rates for women in India in 2005-06, was higher by about 15-20 percentage points when there was no access to toilets; or when water was not available on premises and had to be fetched from outside; or the type of cooking fuel used due higher indoor air pollution. This study further reports that even after wealth effects, rural/urban residence and other socio-demographic variables were controlled for, each of these variables were individually relevant in explaining the presence or absence of CED among women in India. Dahiya and Viswanathan (2015) also explore the impact of infrastructure on women's BMI in rural and urban areas across the BMI quintiles. If drinking water is purified then it has a significant impact while covering it with a lid does not make any significant difference. The impact of water purification is higher for the lowest BMI quintile than for the higher BMI quintiles. Access to regular piped water compared to those who have to fetch water from a longer distance and takes time (the reference category) has a significant impact with the effect more visible for the higher BMI quintiles. On the other hand those who do not have access to water within the premises but it takes less time are also better off than the reference category mentioned above. The use of clean cooking fuel has an impact for higher BMI quintiles and is not significant for the lower BMI quintiles. This may be because for lower BMI quintiles there is a possibility that most of them use dirty fuels for cooking and hence there is not much variability and hence one does not observe the impact. The results for sanitation are as expected with any other form of sanitation having a large positive influence compared to open defecation with the magnitude of this coefficient being similar across the BMI quintiles.

Agriculture and BMI

Singh et al (2012) finds that the probability of finding a woman with low BMI is highest for those whose husband's occupation is in the primary sector.While trying to connect patterns of trends in agricultural growth to changes in undernutrition rates among children and women, Headey *et al* (2011) finds that the patterns are mixed. The study finds agricultural GDP per worker to have a negative significant association with stunting but not with underweight at the state level. Compared to child undernutrition rates, prevalence rates of low BMI among women responded the most to changes in indicators

[4]Studies have documented that cooking in firewood provides a different taste to the preparation and the use of toilets within the house is not considered clean enough.

like wealth and per capita GDP growth. From the perspective of agriculture, women's low-BMI rates reduced due to changes in agricultural GDP per worker. The study further shows that, after controlling for other covariates including economic status, women and men involved in agricultural work had lower average BMI, while in the case of women the gap was not (statistically)significant when compared to unskilled non-agricultural employment. Gulati*et al* (2012) show that the level of agricultural performance or income has a strong and significant negative relationship with indices of undernutrition among adults and children; suggesting association between improvement in agricultural productivity and reduction in undernutrition. The differences in the results of these two studies on the impact of agriculture on undernutrition is due to the nature of data and the measures used and hence the type of analysis. Headey *et al* (2011) use a two-period data while Gulati*et al* (2012) use a single cross-section so the former is a medium run effect while the latter is a long run effect as a single cross-section is being compared. In the former study agricultural growth and other forms of agricultural performance including agricultural GDP per worker is used while in the latter study the agricultural GDP is taken as a proportion of rural population. There is also a difference in the measure of undernutrition: Heady *et al* consider proportion of women with low BMI while Gulati*et al* consider a normalized index of adult undernutrition that comprises of only thin women and (also) men. Dahiya and Viswanathan (2015), find that the BMI of women who participate in agricultural work have lower average BMI compared to those who do not work. However, between agricultural and non-agricultural labour, the average BMI is lower among the latter than the former. Between those who are in farming and agricultural labour, the latter are worse off. There are also variations across BMI quintiles, the average BMI is lowest across all the quintiles for those who work as agriculture labour and also in one's farm. These results perhaps reflect the nature of physical activity carried out by these women in the labour market and not so much whether women in agriculture have a lower BMI than those who are not in agriculture.

Thus, one finds mixed results in the empirical literature on the effect of agriculture on women's BMI giving scope for further exploring the nature of the relationship. The next chapter discusses the methodology followed in this study for carrying out such an analysis.

Chapter 5

METHODOLOGY

The empirical analysis firstly captures the variations in BMI across several covariates (mentioned in Table 1) that are likely to affect BMI. The first sub-section provides a detailed analysis of the variations in BMI cross-tabulated across several of the explanatory variables. The main intention is to understand how different determinants are correlated across the distribution of BMI. The focus of this paper is on features of farming, dietary diversity of the households and aspects of women's empowerment. However, other variables that are also likely to influence nutrition status like economic status, access to basic amenities like water, sanitation, health and clean cooking fuel are also included in the econometric model while explaining the variations in BMI. This model is estimated using the quantile regression model where dietary diversity could possibly be endogenous. So an instrumental variable quantile regression model is estimated. Before we discuss this model specification we also estimate two other specifications. The following sub-sections discuss these in more details.

Modeling the Likelihood of CED

Different ranges of BMI refer to different states of nourishment: Chronic Energy Deficiency (CED) or undernutrition is when BMI is less than 18.5; Normal when BMI is above 18.5 but below 25; overweight when BMI is between 25 and 30; and obese when BMI is 30 or above. For a developing country like India, a concern for policy intervention is the issue of undernutrition than malnutrition due to high levels of BMI, though latter is also a becoming concern for public health in urban areas. So we begin with an analysis that indicates the determinants of CED among women in rural areas. The model is estimated using a probit model where the dependent variable takes a value 1 if the woman has BMI below 18.5 and 0 otherwise. The estimation of the probit model is given below. The following log-likelihood function is maximized to obtain the estimators of the unknown coefficientβ.

$$L(\boldsymbol{\beta} \mid Y, \boldsymbol{X}) = \prod_{y=1} Pr(y_i = 1 \mid \boldsymbol{X}_i) \prod_{y=0} Pr(y_i = 0 \mid \boldsymbol{X}_i)$$

$$= \prod_{y=1} [\Phi(\boldsymbol{X}_i \boldsymbol{\beta})] \prod_{y=0} [1 - \Phi(\boldsymbol{X}_i \boldsymbol{\beta})]$$

$$ln\, L(\boldsymbol{\beta} \mid Y, \boldsymbol{X}) = \sum_{y=1} [\Phi(\boldsymbol{X}_i \boldsymbol{\beta})] \sum_{y=0} [1 - \Phi(\boldsymbol{X}_i \boldsymbol{\beta})] \tag{1}$$

Where Pr($Y_i=1/\boldsymbol{X}$)= $\Phi(\boldsymbol{X_i}\beta)$, $\Phi(t) = \int_{-\infty}^{t} \frac{1}{\sqrt{2\pi}} exp(-\frac{z^2}{2})dz$, $\boldsymbol{X}$ is the vector of explanatory variables.

This model is first estimated for all the households and is used to find out if the likelihood of CED is lower or higher among women in a farm household compared to a non-farm household. Three different variants of this model is estimated to capture different aspects of agriculture as explanatory variables in the model.

(i) In the first variant, categorical variables representing the major source of household income is used. Cultivation or managing the livestock or agricultural wage labour as the major source of income represents an agricultural household. A statistically significant coefficient with a positive sign for a particular source of income would imply that women in such a household is more likely to have CED when compared to a reference household say, whose major income source is 'other source'. More details on the types of income sources as available in the data is discussed in the section on data and subsequently in the section on results.

(ii) In the second variant, share of income from farming, livestock rearing, agricultural property and agricultural wages and also share of non-agricultural wages are included as separate variables. The significance of any or all the first three variables in the model would capture the differences in BMI between agriculture and non-agriculture household. The positive coefficient would then indicate agricultural households to be more likely to have CED and vice-versa for a negative coefficient.

(iii) In the third variant, a dummy variable for whether the household cultivates land or not is used along with share of income from agriculture and allied activities. So, on the one hand it assesses the impact of cultivation on the likelihood of CED and on the other, the impact of agricultural income compared to other sources of income when possibilities of diversified income earning activities exist.

Finally, this is followed by another set of estimations based only on women from farm households to assess the impact of diversity in crop production and livestock ownership to her likelihood of CED.

Modeling Variations in BMI: Quantile Regression

In a study on the analysis of nutritional status using anthropometric data or using nutritional intake data, recent studies have preferred quantile regression method (QRM) over the regression model that estimates the mean equation (Koenker, 2005). Such a method provides estimates of the impact of the determinants (and control variables) across the distribution of the nutritional variable say, BMI, or z-scores of child underweight or child stunting instead of a single estimate that captures the average effect of the determinants as would be the case in a classical least squares model using the method of OLS. QRM is also less sensitive to outliers and has better properties in the presence of heteroscedasticity. Drawing from the explanations in Bassole (2007) we present the method of estimation as below:

The estimate $\boldsymbol{\beta}_\tau$ is the set of estimated coefficients for the τ^{th} quantile. A quantile represents a particular proportion of sample below q_τ. If F represents the cumulative distribution function (CDF) of the variable Y then:

$$\tau = P(Y \leq q_\tau) = F_Y(q_\tau), \quad 0 < \tau < 1 \tag{2}$$

For instance, quartiles represent 25 percent observation in each group when we order the continuous variable (Y) under consideration say, BMI so that (2) is stated as: $0.25 = P(Y \leq q_{0.25}) = F_Y(q_{0.25})$.

$\boldsymbol{\beta}_{\tau}$, is obtained by maximising a weighted sum of least absolute deviations of the residuals of the linear econometric model with the weights representing the τ^{th} quantile as indicated below:

$$\hat{\boldsymbol{\beta}}_\tau = \min_{\beta_\tau}\left[\sum_{i:y_i \geq X_i\beta_\tau} \tau\left|y_i - \boldsymbol{X}_i\boldsymbol{\beta}_\tau\right| + \sum_{i:y_i < X_i\beta_\tau} (1-\tau)\left|y_i - \boldsymbol{X}_i\boldsymbol{\beta}_\tau\right|\right] \tag{3}$$

Choosing the $\hat{\beta}_\tau$ that minimizes the left hand side of the above expressions is equivalent to finding that $\hat{\boldsymbol{\beta}}_\tau$ which makes $\mathbf{X}\hat{\boldsymbol{\beta}}_\tau$ as the best fit quantiles of the distribution of Y for a given **X**. The minimization problem is solved as a linear programming problem and the statistical software STATA 13.0 has been used for this purpose[5].

[5] See the section on 'methods and estimation' in STATA, 13.0 documentation, pp. 1786-1790.

Several of the recent studies have preferred to use this method: Burchi (2010) for child's nutrition in Mozambique; Borooah (2005) for child-height-for age in India; Aturupaneet al, (2008) for stunting and underweight among Sri Lankan children; Kandpal and McNamara (2009), Mazumdar (2010) for inequality in nutritional outcome of children in India; Block et. al. (2012) for undernutrition among children in developing countries; Seshadri (2009) for BMI and heights of women in India; Chen and Tseng (2010) for BMI of women in Taiwan; Sinha (2005) for calorie intake among rural Indians; Vepa*et al* (2015a and 2015b) for child underweight rates across districts of India. The results from these studies substantiate the fact that such a statistical methodology helps in assessing the variation in impact across different levels of nutritional indicator rather than its mean and provides useful insights both from a behavioural perspective as well as for policy inputs.

This method is preferred over the mean regression (OLS) in this study so as to capture the differences in the impact of several determinants like dietary diversity, water quality or type of sanitation and women's social status across increasing levels of women's BMI. The mean regression only focuses on the marginal effect for the average level (normal levels) of BMI. Thus, it becomes essential for an indicator like BMI where low and high levels both reflect malnourishment but of a different nature to be assessed differently. Documenting or quantifying the differential impacts across different quantiles helps us to understand the impact of a public policy (ex-post) or suggesting an alternative policy intervention (ex-ante). Alternatively, the levels of BMI can be grouped and assessed as categorical variables (see, Singh *et al*, 2012) but we do not prefer this since we end up 'discretizing' a continuous variable and lose out on a lot of information. Though, we estimate a binary choice model for assessing the likelihood of CED (as mentioned in the previous section) to compare between farm and-non-farm households but this is only as a preliminary analysis.

While estimating the quantile regression model it is likely that there can be potential endogeneity in one of the explanatory variables, dietary diversity. Therefore, we specify the final econometric model taking this into consideration and find that the two equation model helps us in a better explanation of the variations in BMI of women in farm household. The dietary diversity equation is modeled so as to capture the behavior of a farm household while the BMI equation includes the predicted value of the dietary diversity along with other individual and household level variables. This model enables us to explain the relationship between BMI and farming in a more realistic manner. This is explained in some detail in the following sub-section.

Modeling Variations in BMI with Endogenous Variable: Two-stage Instrumental Variable Quantile Regression

Most studies that have used quantile regression ignore the possibility of potential endogeneity of some of the regressors as endogenous regressors lead to inconsistent estimates[6]. The imminent question is which of the variables are potentially endogenous and which ones are exogenous. Evidence from the literature shows that income or consumption is usually considered endogenous[7]. Burchi (2010) considers the endogeneity due to possible measurement error in these variables while others like Chen and Tseng (2010) considers nutrient intake, health behavior and nutrition knowledge to be potentially endogenous as individuals make a choice and hence are determined by several exogenous factors. Bassole (2007) on the other hand does not provide any reason to consider income to be potentially endogenous while estimating the instrumental variable QRM for the determinants of child health in Senegal. In this study we consider dietary diversity (for a farm household in our context) to be potentially endogenous as the decision to consume a variety of food items is determined by access to it directly from home production (availability) and/or indirectly from the purchase (involves affordability due to income effect and also availability if access to markets is easy). The exogenous variables in the dietary diversity equation are income, wealth index, land owned, crop production diversity, ownership of different types of livestock, caste, religion, education of the head of household, household size and composition. In the next chapter we give a brief discussion on the choice of determinants in the dietary diversity equation.

If both the equations were to be estimated for individuals then this instrumental variable quantile regression model could be supported by the conceptual framework of health production function provided by Becker (1965) and used in Chen and Tseng (2010). Under those conditions, an individual's health is determined by her nutrient intakes, health behavior (physical activity and health seeking and care), nutrition awareness and other exogenous factors (environmental conditions, socio-demographic and cultural features, economic condition and genetics). The individual's nutrition intake is influenced by her health behavior, nutrition awareness and some of the exogenous

[6]Chernozhukov and C. Hansen (2013) provide detailed overview of the theoretical discussion on this.

[7]There are also studies that allow for endogenous regressors for a single (average) model as in Venkataramani (2010). In this study instrumental variable approach is used to isolate non-genetic from genetic mechanisms behind intergenerational associations in height with parental height being the endogenous variable in the model for child's height-for-age z-scores. Conditions faced by the parents during their year of birth and early childhood serve as instruments as early life conditions influence later life outcome and that height determining genes do not change within a short term say, within a generation. A more recent study by Mukhopadhyay and Crouse (2014) considers BMI as potentially endogenous in a wage equation and estimate the model using instrumental variable quantile regression model.

factors. Extending this to a regression model an individual's health is captured by BMI as determined by a set of factors including nutrient intake which is endogenous and hence an instrumental variable approach is used.

In this study we follow the steps as in Chen and Tseng (2010) for estimating the instrumental variable QRM. A two-stage model is estimated to capture the impact of crop and livestock diversity on nutrition. In the first stage a linear regression model is estimated with dietary diversity as the dependent variable. The predicted value of dietary diversity is used as a regressor in the second stage where the dependent variable is BMI. However, the second stage model is estimated as a quantile regression model. In the QRM the results are reported for six quantiles of BMI i.e., 10th,20th,40th,60th, 80th and 90thquantile.The lower quantiles would encompass those who are CED while the top quantiles would include those who are overweight and obese while the middle quantile would represent the normal levels. The first stage equation is the household level dietary diversity equation taken as a function of household level characteristics and regional features. In the second stage QRM, the BMI for women in the age of 20-45 years is estimated using several individual and household level characteristics including the (endogenous) dietary diversity variable predicted from the first stage. The next chapter defines the variables used in the analysis.

Chapter 6

DATA

The analysis has been carried out using data from the 2005 India Human Development Survey (IHDS) (Desai, et. al, 2007) conducted jointly by University of Maryland and National Council of Applied Economic Research (NCAER) between 2004 and 2005. It contains information from 41,554 households in 1,503 villages and 971urban neighborhoods across all the states and union territories of India.

The data set provides information on variables related to health, education, employment, economic status, marriage, fertility and social capital. The data provides regional segregated information and offers gender centric and institutional information. The survey included two questionnaires, one for the household head and the other for the eligible women, who is typically the wife of the household head. The questions related to household wealth, income and expenditure were asked from the household head while the questions related to health, education and some other social indicators were administered to women.

Farm Households

Since the focus is on rural farm households, only adult women among farm households in rural India are considered in this analysis. A household which has reported cultivation of at least one crop in the previous year is referred to as a farm household. Among the 26,734households in the rural sample, 12,143 grow at least one crop. Around 98 percent of these farm households own and cultivate land while the remaining do not own land but cultivate on somebody else's land. This would clearly exclude pure agricultural labour households as the purpose of the study is to understand the variations in women's BMI among farming households.However we do examine some comparisons across these different types of households in a preliminary analysis. This would however include households that cultivated small parcels of land say, 0.1 hectares but report that their major source of income is not from farming and was either from agricultural labour or from non-agricultural labour activities.

BMI of Adult Women as Nutritional Indicator

In this study BMI of women between 20 to 45 years of age is taken as the nutrition outcome variable for analysis. As mentioned earlier, BMI is a person's weight in kilograms divided by square of height in meters. For women, height is stable between 20-45 years-large part of linear growth is attained by menarche but studies usually consider 20 years as the starting age to analyse adult women's heights and the ending age is usually taken as 45years after which stooping may set in. Given that height is not expected to vary in this age-group, the changes in BMI are effectively changes in body weight, not affected by any biological changes but mainly due to various social, economic and environmental factors. In the sample 19,220 women are in this age group while 10,559 women among them belong to households that grow at least one crop. After excluding outlier values for income, consumption and production, totaling to 687, the final sample size is 9882 women.

For the preliminary data analysis, women's BMI- separately from farm and non-farm farm households- is converted into five quantiles (i.e) 20 percent women in each quantile and this is referred to as BMI quintiles. CED rates as mentioned before,refer to the percentage of women with BMI below 18.5 within a particular group/category.

Factors Influencing Dietary Diversity, BMI

Given the nature of information in the database, the variables that are likely to affect dietary diversity and women's BMI are pertaining to agriculture, economic prosperity, socio-demographic features, women's status, access to basic amenities and health care facilities and regional variables. Alternatively, these can also be grouped as household, individual and regional variables.A summary of the covariates to be used in different variants of the econometric analysis are presented in Table 1 below.

Table 1: Brief Summary of the Explanatory Variables

Variable Name	Type	Description
Agriculture Variables		
Crop ProductionDiversity-PDI	Continuous	An index measured witharea share including food and non-food crops. The index is defined as $1-\sum_{i=1}^{k} p_i^2$ where p_i is share of cultivated area for the i^{th} crop in the total cultivated area for a farm household.
Total area under cultivation	Continuous	Logarithm of area under cultivation in acres
Net income from all the agricultural activities of the household includes livestock and agricultural wage labour	Continuous	Logarithm of net income in Rs.
Share of agricultural income	Continuous	Share of net income from agriculture and allied activities in total household income
Ownership of Livestock	Discrete	Dummies variables for ownership categorised into (a) milch animals: cows and buffaloes, (b) small ruminants- sheep and goats, (c) poultry and other animals and (d) draught animals (as the omitted category)
Economic Variables		
Income	Continuous	Logarithmofper capita monthly (household) Income in Rs.
Consumption	Continuous	Logarithm of per capita monthly (household) consumption expenditure in Rs.
Asset ownership	Categorical	5 quintiles (poorest, poor, mid-wealth, rich & richest) of asset index estimated using principle component analysis; poorest quintile is taken as reference category
Income diversity	Continuous	Share of income in total household income from different economic activities: cultivation, livestock rearing, agricultural property, agricultural wage income, non-agricultural wage income, others (omitted category); or simply from agricultural income and non-agricultural wage income and others (omitted category).
Major Source of Income for the household	Categorical	Seven Categories: Cultivation, Agricultural Wage Labour, Non-agricultural Wage Labour, Artisan, Trade and Business, Salaried and Professional, Others (Reference)

(contd... Table1)

Dietary Variable		
Dietary diversity index-DDI	Continuous	Index defined as in PDI and based on expenditure share of different food items
Women Empowerment Variables		
Gendered practices with positive attributes given a value 1 and 0 otherwise.	Categorical	(a) Has permission to go to the grocery store (Yes=1, No=0) (b) Women take meal along with men (Yes=1, No=0) (c) Do not practice purdah (Yes=1, No=0) (d) Quantiles of women autonomy index using different aspects of gender relations is calculated using principle component analysis and the first category is taken as the reference Separate attributes as in (a)-(c) give better results and used in the final analysis
Socio-Demographic Variables (Household level)		
Level of Education for highest educated member-first stage regressor	Categorical	Five categories are: not literate (reference), primary and middle schooling, secondary schooling, higher secondary schooling & graduation and above
Religion	Categorical	Four major religions: Hindus (reference), Muslims,Christians and Others
Caste	Categorical	Five major castes: Upper Caste Hindus, Other Backward Caste, Scheduled Castes, Scheduled Tribes (reference) and Other Castes.
Household composition	Continuous	Ratio of number of members in a particular age group to total household size; The age groups are: 0-4 years (reference), 5-14 years, 15-60 years, >60years
Household size	Continuous	Number of persons in the household excluding migrants
Access and Use of Household Amenities		
Quality of Water	Categorical	Whether water is treatedbefore drinking (Yes=1, No=0)
Sanitation	Categorical	Four categories are: 1= Open defecation (reference), 2= Traditional toilet, 3= Pit Latrine, 4= Flush toilets
Access to electricity	Categorical	Yes=1, No=0
Type of cooking fuel and type of ventilation in the kitchen to capture indoor pollution	Categorical	Cooking fuels like firewood, dung, crop residue, charcoal etc. are referred to as dirty fuels while kerosene and LPG are referred as clean fuel. (i)cooking area has no proper ventilation with use of dirty fuel, (ii) cooking area has some ventilation(ii)outdoor cooking with a dirty fuel,

(contd... Table1)

		and (iv) clean fuel.
Individual Variables		
Age	Continuous	Age of woman
Completed level of education of the woman	Categorical	Five categories: Not literate (reference),primary, secondary, higher secondary and graduation & above
Employment type of the woman	Categorical	Six categories: Farm work, farm work and agricultural wage labour, agricultural wage labor, non-agricultural wage labor, salaried work and business, not in the labour market (reference)
Access to antenatal care during pregnancy	Categorical	Four categories: not pregnant (reference),pregnant but antenatal care not accessed,pregnant with antenatal access from doctor/nurse, and pregnant with access to traditional methods alone
Type of health care sought for short-term illnesses (like cough, cold, fever etc.) in the last 30 days	Categorical	Whether ill and seek medical help from different types of health facilities as five groups: Not ill (reference), ill but don't seek medical help,ill and visit public facility; ill and visit private facility,and ill & take traditional medicines

The analysis does not use all the factors in a single econometric model and the choice varies depending on the nature of dependent variable which will become evident as we discuss it in next two chapters on empirical analysis.

Chapter 7

EMPIRICAL EVIDENCE: PRELIMINARY ANALYSIS

Apart from discussing the nature of different variables used in the analysis, this chapter mainly presents cross-tabulation of the covariates either across BMI quintiles or CED rates. This enables us to understand the nature of association of the regressors with BMI.

CED rates and Mean BMI

We observe that most rural households in India depend on agriculture as a main source of income and that many agricultural households have diversified sources of income. Among the rural women aged 20-45 years, 36 percent of them belong to households that report cultivation as the major source of income while about 21 percent of these women belong to households that report agricultural wages as the main source of income (Table 2a). The average share of net farm income which includes income from cultivation, livestock and agricultural property is 63 percent among women in cultivator households. For women in several other types of household, share of farm income in total household income is not negligible either.

As for undernourished (or CED) women, that is those with BMI less than 18.5, we observe that those in wage labour households are the worse off with non-agricultural labour being worst off than all others, and women in households reporting salaried and professionals are the best off; women in cultivator households are somewhat in the middle. It is, however, observed that the mean BMI of women in all these households is well above 18.5 with lower standard deviation among wage labour households indicating a narrower distribution around the mean compared to women in other types of households.

Table 2a: Distribution of Women Aged 20-45 Years, CED rates and Mean BMIAcross Major Sourcesof Income in Rural Areas

Major Source of Income	Distribution (%)	Average Share of Farm Income (%)	Grow at least one crop (%)	CED (%)	Mean BMI	Standard Deviation of BMI
Cultivation	36.0	62.8	94.5#	27.6	20.5	3.21
Agricultural Wage Labour	20.7	12.7	28.5	30.6	20.1	2.98
Non-agricultural Wage Labour	17.6	11.0	30.4	34.7	19.9	3.00
Artisan	4.9	8.8	22.7	22.7	21.3	3.67
Trade & Business	6.7	9.1	30.4	22.9	21.3	3.61
Salaried & Professionals	11.0	13.8	40.7	20.7	21.4	3.30
Others	3.2	18.1	39.4	24.3	21.3	3.44
Total	100.0	30.2	54.1	28.1	20.5	3.24

Note:(1) Distribution of women across households withdifferentmajor sources of income; (2) Share of farm income is in total income; (3) CED or chronic energy deficiency is BMI below 18.5; (4) The unit for mean and standard deviation of BMI is kg/m^2. #This number is expected to be 100 percent but about 5 percent of women are from households with cultivation as major source of income either report no land cultivated or have nil crops grown in the previous agricultural year. Such data are eventually excluded from the sample in the analysis of farm households.

In order to assess if CED rates and mean BMI are statistically different across women in households with different sources of income, a regression model is estimated with dummy variables representing the different sources of income.

$Y_i=\beta_1M_{1i}+\beta_2M_{2i}+\beta_3M_{3i}+\beta_4M_{4i}+\beta_5M_{5i}+\beta_6M_{6i}+\beta_7M_{7i}+u_i$ (1)

M_{1i}=1 if the i^{th} woman belongs to a household with cultivation as a major source of income.

=0 otherwise

M_{2i}=1 if the i^{th} woman belongs to a household with agricultural wage labour as the major source of income.

=0 otherwise

M_{3i}=1 if the i^{th} woman belongs to a household with non-agricultural wage labour as the major source of income.

=0 otherwise

M_{4i}=1 if the i^{th} woman belongs to a household with artisanal work as the major source of income.

=0 otherwise

M_{5i}=1 if the i^{th} woman belongs to a household with trade and business as the major source of income.
=0 otherwise
M_{6i}=1 if the i^{th} woman belongs to a household with regular salary or profession as the major source of income.
=0 otherwise
M_{7i}=1 if the i^{th} woman belongs to a household with others sources like rents, pensions etc. as the major source of income.
=0 otherwise

(1a) When the dependent variable $Y_i$in equation 1takes the value 1 if the woman is CED and 0 otherwise, then the expression $E(Y_i|M_{1i}=1, M_{ji}=0, \forall\ j\neq1)=\beta_1$implies that the estimated coefficient $\hat{\beta}_1$ from the data is the mean CED rate of the women who are from households with cultivation (M_{1i}=1) as the major source of income. The estimated coefficient values are multiplied by 100 to show the rates in percentages in Table 2b. The lower part of Table 2b presents the results of the test of hypothesis:
H_0: $\beta_i=\beta_j$, H_1: $\beta_i\neq\beta_j$; i and j here refer to two different majorsources of income.

(1b) We also estimate another model with Y_i as the woman's BMI. In this model, $E(Y_i|M_{1i}=1, M_{ji}=0, \forall\ j\neq1)=\beta_1$ implies that the estimated coefficient $\hat{\beta}_1$ from the data is the mean BMI of the women who are from households with cultivation (M_{1i}=1) as the major source of income. Similarly each of the estimated coefficients is the mean BMI of the women from households with differentmajorsources of income.

Thus, the null of testing for equality of some or all the coefficients in the estimated model above is equivalent to testing for the mean BMI to be same for women from households with different sources of income.

The results based on the F-tests show that the mean BMI (CED rates) of women in cultivator households is higher (lower) than those in agricultural wage labour followed by those in non-agricultural wage labour. Further, women in households with either 'trade& business' or 'salaried & professionals' or 'others' as major source of income have similar mean BMI and CED rates as the nulls of equality of those coefficients cannot be rejected based on the p-value of the test statistic.

Table 2b: Mean Differences in BMI and CED Rates Across Major Sources of Income.

	CED (percent)		BMI (kg/m^2)	
Estimated Coefficients				
Major Source of Income	Coefficients	p-value	Coefficients	p-value
Cultivation (β_1)	27.7^{***}	0.000	20.5^{***}	0.000
Agricultural Wage Labour (β_2)	30.7^{***}	0.000	20.1^{***}	0.000
Non-agricultural Wage Labour (β_3)	34.7^{***}	0.000	19.9^{***}	0.000
Artisan(β_4)	22.7^{***}	0.000	21.3^{***}	0.000
Trade & Business(β_5)	22.9^{***}	0.000	21.3^{***}	0.000
Salaried & Professionals(β_6)	20.7^{***}	0.000	21.4^{***}	0.000
Others(β_7)	24.3^{***}	0.000	21.3^{***}	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value
H_0: β_1=β_2, H_1: $\beta_1 \neq \beta_2$	11.82^{***}	0.000	29.39^{***}	0.000
H_0: β_2=β_3, H_1: $\beta_2 \neq \beta_3$	14.33^{***}	0.000	8.31^{***}	0.000
H_0: β_1=β_2= β_3, H_1: At least one is different	28.35^{***}	0.000	38.47^{***}	0.000
H_0: β_4=β_5= β_7, H_1: At least one is different	0.26	0.768	0.03	0.973
H_0: β_1=β_6, H_1: $\beta_1 \neq \beta_6$	38.66^{***}	0.000	127.54^{***}	0.000

Note: (1) The above coefficient estimates are obtained equation (1) for two types of dependent variable as in (1a) and (1b) respectively. (2) *p-value<0.10; ** p-value <0.05; *** p-value <0.01 and this applies henceforth for all the tables below.

Agriculture Related Variables

A primary interest of this study is to understand the role of farm production diversity in determining women's BMI. Farm production diversity has been classified into crop production diversity and livestock ownership diversity.

Crop Production Diversity:Crop production diversity is calculated using Production Diversity Index (PDI)=$1-\sum_{i=1}^{k} p_i^2$ where p_i is either the share of cultivated area for the i^{th} crop in the total cultivated area or the share of gross-revenue for the i^{th} crop in the total gross revenue. The crops include both food and non-food crops. The larger the value of the index larger is the diversity. Crop production diversity has been captured by the total number of crops grown by other studies using this data (Bhagowalia, *et al*, 2012a). Area share is preferred to the gross-revenue share in this study as gross-revenue does not take into account the expenditures incurred for growing the different crops and hence the index may not appropriately measure the production diversity. However, a preliminary analysis is provided in Table 3 using all three measures of diversity.

Table 3 below shows crop production diversity indicators for different BMI quintiles. The median number of crops grown is two in general, and for women in the higher BMI quintile it increases to three. Further, the production diversity index based on area as well as total value is moderate between 0.4 and 0.5 and increases marginally across the BMI quintiles. The low value for diversification index could be because the maximum number of crops grown is about 14 and does not include varieties of vegetables, fruits and flowers cultivated as well as that from homestead garden. Thus, overall women in higher BMI quintiles belong to households with more crop diversification.

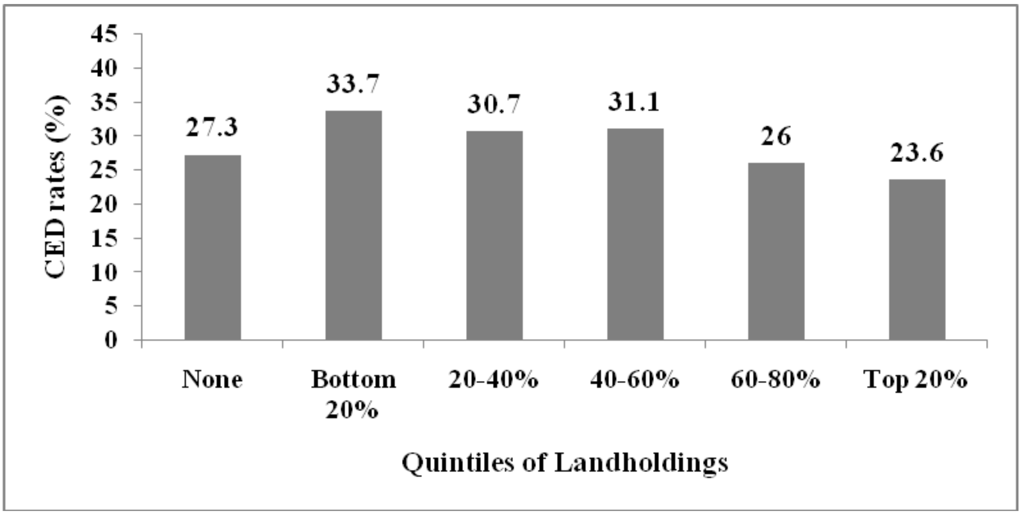
Table 3: Average of Production Diversity Index (PDI) across BMI Quintiles

		PDI based on	
BMI quintiles	**Median Number of Crops Cultivated**	**Area**	**Value**
Bottom 20percent	2	0.44	0.39
20-40percent	2	0.44	0.40
40-60percent	2	0.45	0.39
60-80percent	3	0.46	0.41
Top 20percent	3	0.48	0.41
Total	2	0.45	0.40

Note:(1) BMI Quintiles represents the distribution of women aged 20-45 years in farm households only. (2) PDI-Production Diversity Index is as defined in the text. (3) Area is in acres and value in rupees is the total gross revenue from the cultivation of each of the crops.

Area UnderCultivation: The impact of production diversity needs to be assessed after controlling for the total (land) area under cultivation, as a household could have a large area but perhaps mono-cultivation is practiced. The logarithm of total area under cultivation is used and primarily serves the purpose of a control variable while assessing the impact of production diversity. Figure 1 shows that women in households who do not possesses any land havethe lowest CED rates with CED rates similar for the 2nd and 3rd quintiles and lower for the upper quintiles of cultivated land.

Figure 1: CED Rates AmongWomenAcross Quintiles of Cultivated Land (inpercent)



Note: (1) None represents those households who do not possess any land. (2) The women in households which posses land have been categorised in 5 equal groups or quintiles.

Table 4a shows the distribution of women across BMI quintiles in each of the land categories defined by those who have not cultivated land and the remaining households divided into quintiles of cultivated land. Among those who do not cultivate land a higher share belong to the top BMI quintile and also indicating higher proportion of women who are overweight and obese. In each of the bottom three land quintiles, the percentage share of women in the bottom 20 percent of the BMI quintile is nearly the same. The distribution of women in the highest land quintiles is almost a reverse of that in the lowest land quintile. There is a gap of about 10 percentage points in the CED rates between the bottom and top land quintiles. Thus, as could be expected women in households with large area of cultivated land are better off in BMI levels than those with either no cultivated land or in households with lesser cultivated area.

Table 4a: Cross-Tabulation of Women Across BMI Quintiles and Categories of Cultivated Land

BMI quintiles	Land Categories Based on Cultivated Land					
	None	Bottom 20 percent	20-40 percent	40-60 percent	60-80 percent	Top 20 percent
Bottom 20percent	19.6	23.4	22.2	23.3	17.8	16.4
20-40percent	19.0	22.3	20.8	20.9	20.5	20.4
40-60percent	19.9	20.5	21.2	19.5	19.8	19.6
60-80percent	19.6	18.4	19.3	17.8	23.7	22.6
Top 20percent	22.0	15.7	16.8	18.5	18.2	20.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution of women (%)	48.0	10.4	10.4	10.4	10.4	10.4
CED rates (%)	27.3	33.7	30.7	31.1	26.0	23.6

Note: The study uses data only for households that cultivate at least one crop, however for purpose of comparison women's BMI in rural households that do not cultivate land is also shown here.

We now estimate a regression model (only) on the groups of land cultivated based on the following specification:

$$Y_i=\beta_0L_{0i}+\beta_1L_{1i}+\beta_2L_{2i}+\beta_3L_{3i}+\beta_4L_{4i}+\beta_5L_{5i}+u_i \qquad (2)$$

L_{0i}=1 if the i^{th} woman belongs to a household with no land categories.
=0 otherwise

L_{1i}=1 if the i^{th} woman belongs to a household with cultivated land in quintile 1.
=0 otherwise

L_{2i}=1 if the i^{th} woman belongs to a household with cultivated land in quintile 2.
=0 otherwise

L_{3i}=1 if the i^{th} woman belongs to a household with cultivated land in quintile 3.
=0 otherwise

L_{4i}=1 if the i^{th} woman belongs to a household with cultivated land in quintile 4.
=0 otherwise

L_{5i}=1 if the i^{th} woman belongs to a household with cultivated land in quintile 5.
=0 otherwise

As explained earlier, the dependent variable, model specification and hypothesis testing are similar to that for the major income source explained earlier and given in equation 1. Similar to Table 2b the results below in Table 4b show the differences in mean CED rates and mean BMI across households in rural areas who do not possess any land and of other land cultivated categories further classified into quintiles of land cultivated. The coefficients for categories of cultivated land are tested for equality as indicated below: H_0: $\beta_i=\beta_j$, H_1: $\beta_i \neq \beta_j$; i and j here refer to two different land categories.

Table 4b: Comparison of Dietary Diversity Index, BMI and CED Rates Across Categories of Cultivated Land

	Dietary Diversity Index		**CED Rates (%)**		**BMI (kg/m^2)**	
Categories of Land Cultivated	Coeffnts	p-value	Coeffnts	p-value	Coeffnts	p-value
No land (β_0)	0.818	0.000	27.2***	0.000	20.7***	0.000
Bottom 20 percent(β_1)	0.812	0.000	33.6***	0.000	20.1***	0.000
20-40 percent(β_2)	0.810	0.000	30.5***	0.000	20.2***	0.000
40-60 percent(β_3)	0.819	0.000	31.1***	0.000	20.3***	0.000
60-80 percent(β_4)	0.829	0.000	26.1***	0.000	20.6***	0.000
Top 20 percent(β_5)	0.841	0.000	23.6***	0.000	20.9***	0.000
Tests of hypothesis			F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0 \neq \beta_1$	9.49***	0.002	32.84***	0.000	46.02***	0.000
H_0: $\beta_1=\beta_2$, H_1: $\beta_1 \neq \beta_2$	0.62	0.430	4.68**	0.031	0.18	0.668
H_0: $\beta_2=\beta_3$, H_1: $\beta_2 \neq \beta_3$	10.49***	0.001	0.15	0.699	0.64	0.422
H_0: $\beta_3=\beta_4$, H_1: $\beta_3 \neq \beta_4$	14.80***	0.000	11.57***	0.001	9.87**	0.002
H_0: $\beta_4=\beta_5$, H_1: $\beta_4 \neq \beta_5$	23.39***	0.000	3.14*	0.076	6.85*	0.008
H_0: $\beta_0=\beta_4$, H_1: $\beta_0 \neq \beta_4$	25.18***	0.000	0.86	0.354	1.28	0.257
H_0: $\beta_0=\beta_5$, H_1: $\beta_0 \neq \beta_5$	133.28***	0.000	10.77**	0.001	5.03**	0.024

Note: The above are coefficients estimates obtained by regressing BMI and CED respectively on the dummy variables for categories of cultivated land.

We find that mean CED rates and mean BMI are similar for women in land quintile 2 and 3 as the null of H_0: $\beta_2=\beta_3$, is not rejected against the alternative H_1: $\beta_2 \neq \beta_3$ at 1 percent level of significance. Similarly those without land are perhaps dominated by the salaried and professions or in trade and business.The mean BMI or CED rates are no different from those in land quintile 4, since the null of H_0: $\beta_0=\beta_4$, is not rejected against the alternative H_1: $\beta_0 \neq \beta_4$ at 1 percent level of significance. This may be somewhat unexpected as shown in Table 4c below those without land are dominated by those among wage labour(agriculture and non-agriculture) households whose mean BMI (CED rates) was shown to be lower (higher) than these sources of income (Tables 1a and 1b).

Table 4c: Distribution of (Sampled) Women across Major Sources of Income and Categories of CultivatedLand

Major Income Source	Categories of Land Cultivated						
	No land	Bottom 20 percent	20-40 percent	40-60 percent	60-80 percent	Top 20 percent	Total
Cultivation	481	573	1,074	1,357	1,583	1,984	7,052
Agricultural Wage Labour	2,823	355	297	158	95	54	3,782
Non-agricultural Wage Labour	2,276	439	251	154	78	40	3,238
Artisan	655	78	49	36	21	16	855
Trade & Business	850	114	86	52	54	43	1,199
Salaried & Professionals	1,393	261	206	192	138	131	2,321
Others	406	64	56	39	37	38	640
Total	8,884	1,884	2,019	1,988	2,006	2,306	19,087

Net Income from Crops Cultivated: Similar to total area under cultivation, net income from crop cultivation could either be large if a high value single crop is grown or a variety of different crops are grown, which vary in terms of consumption and income needs. Thus net income from cultivation is an important control variable for assessing production diversity - in that for a given net value of total production (and total area cultivated) how does production diversity influence women's BMI. Logarithm of net income is the regressor used in the analysis. The data for net income has been taken as provided in the database. Tables 5a and 5b show the average values of area cultivated, net income, net income per acre for BMI quintiles and land quintiles respectively.

Table 5a: Area Cultivated, Average Incomes and Average Net Income per Acre across BMI Quintiles

BMI Quintiles	Average Area Cultivated (Acres)	Average Annual Net Income from Cultivation ('000 Rs)	Average Annual Net Income Per Acre (Rs/Acre)
Bottom 20percent	17.7	21.2	1545.9
20-40percent	19.7	23.2	1549.8
40-60percent	19.6	25.7	1568.7
60-80percent	21.3	30.2	1442.2
Top 20percent	23.2	37.3	2740.7
Total	20.3	27.3	1745.4

The average values of area cultivated and net income increase across both BMI and land quintiles, while average values of net income per acre shows some variations across BMI quintiles and clearly declines across land quintiles (a feature observed in Gaurav and Mishra, 2011 as well). Instead of area cultivated and net income as two separate variables, net income per acre could also be used and this has also been attempted in the analysis. However, as seen from Table 5a the coefficient may have a negative sign with increasing levels BMI, though it could also become statistically insignificant in the presence of other wealth variables in the model.

Table 5b: Area Cultivated, Average Incomes and Average Net Income per Acre across Quintiles of Cultivated Land

Land Quintiles	Average Area Cultivated (Acres)	Average Net Income ('000 Rs)	Average Net Income Per Acre (Rs/Acre)
Q1	4.5	11.9	4787.0
Q2	10.7	14.5	1492.9
Q3	19.8	18.9	1050.9
Q4	33.8	26.5	818.6
Q5	106.5	61.6	670.8
Total	36.2	27.3	1745.4

Share of Revenue from Sale of Crops in Total Value of the Cultivated Crops: A farm household's higher income either by cultivation of primarily cash crops or by selling a large share of the total crops produced could lead them to purchase and consume a larger variety of food items provided they have access to markets for other food items. On the other hand a household may be well diversified between food and non-food crop with possibilities of further diversification within each of these crop types. Such households may benefit both by income effect of the sale of crops and may also be able to self-consume a part of the food crops cultivated. In order to understand the influences of these on nutrition we consider the share of value of the crops sold in the market to total value of the crops produced in the dietary diversity equation[8]. Dietary diversity (consumption) is available at the household level and not at the individual level and hence we estimate the dietary diversity at the household level and capture its impact on the women's BMI ignoring any intra-household inequalities in consumption.

[8]The data does not report the quantity of food items consumed from home production but reports the quantities sold in the market for each crop or given to the landlord. Based on these we have been able to estimate the value share from home production as a residual but we prefer to use the sale share in the analysis here.

While considering the influence of production diversity on dietary diversity the role of agriculture as a provider of diverse food is taken into consideration. This makes it a unique economic activity compared to all others creating the possibility of increased access to diverse diet from home consumption while it is also a source of income (Kadiyala et al, 2012 and Ruel and Alderman, 2013). The latter feature enables the households to supplement the diets through purchase of food items not grown by the household or which need further processing before consumption provided markets are well developed.In the absence of well integrated markets, households will have to produce foods necessary for a diverse diet and this sense the production and consumption decisions are inseparable (Singh et al, 1986).

Empirical evidence on the role played by income earning activities is stronger while that of own production is mixed. For instance, in Mexico, conditional cash transfers through PROGRESA resulted in higher consumption of calories while production assistance from PROCAMPO for small farmers resulted in a more diversified diet coming from consumption from their own farm produce (Ruiz-Arranz et.al, 2006).Galab and Reddy (2011) find that own production of food crops did not influence diets but children who belong to households which sell more of their produce from non-food (cash) crops in the market had more diverse diets. This result was based on the Young Lives panel data for Andhra Pradesh (India). In an attempt to understand the role played by own consumption and markets in children's dietary diversity in Ethiopia, Hirvonen and Hoddinot *et al* (2014) show that households that produce diverse food items provide for diverse diets for their children but when markets are developed then households depend on market purchase of diverse diets. In this study we attempt to consider the net effect of own production as well as net effect of cash income in influencing dietary diversity after controlling for other factors. We do not attempt to understand the role markets play in influencing dietary diversity or in its absence the relevance of diversity in home productionon diversity in household diets.

Livestock Ownership: The type of livestock owned is grouped into the following categories in the survey (a) milch animals: cows and buffaloes, (b) small ruminants-sheep and goats, (c) poultry and other animals and (d) draught animals. Fish has not been indicated as a separate category and is perhaps part of 'other' which also includes pigs, calves, camels, and other animals. Table 6 shows that the average number of livestock in different categories does not vary substantially but averages for milch animals and poultry increase while that for small ruminants and draught animals declines across BMI quintiles.

Table 6: Average Numbers for Different Livestock Ownership Categories and Averages of Income and Income Share from Livestock RearingAcross BMI Quintiles

BMI Quintiles	Milch Animals	Small Ruminants	Poultry and others	Draught animals	Average Income from Livestock (Rs.)	Average Income Share$ from livestock (%)
Q1	1.04	1.08	1.54	0.92	3082.9	9.4
Q2	1.08	0.88	1.69	0.97	3941.1	10.9
Q3	1.11	0.87	1.67	0.92	3824.5	11.8
Q4	1.20	0.91	1.72	0.91	4094.5	9.9
Q5	1.30	0.68	2.17	0.84	5306.5	11.4
Total	1.14	0.89	1.75	0.92	4019.0	10.7

Note:$The Income share is based on total agricultural income and not household income.

Due to aggregation into such broad groups and the fact that the quantity of self-consumption from livestock ownership is not separately available, the analysis captures livestock diversity the presence or absence of animals for each of the categories as dummy variables. One would expect coefficients in categories (a) to (c) to have a positive influence on dietary diversity (nutrition intakes) and BMI (nutrition outcomes) either through self-consumption or through income effect. The coefficient for numbers in category (d) could either be statistically insignificant as draught animals would not influence nutrition directly or could be negatively significant in comparison to other groups.

Bhagowalia*et al* (2012a) estimate separate equations for food shares and find that ownership of milch animals and goats positively influences milk consumption while it has a negative influence on other food shares like cereals, pulses, vegetables and fruits. Similarly, ownership of poultry influences meat consumption positively while milk and pulses consumption declines. The impact of these on overall dietary diversity measured by the number of food items consumed by the household is found to be mixed. Ownership of milch animals improves dietary diversity, ownership of goats does not have any statistically significant influence and ownership of poultry reduces dietary diversity. Keeping this in mind we could also expect mixed results for our measure of dietary diversity as well but going by what we observe from Table 5 we may expect positive effects for milch animals and poultry, negative effects of small ruminants and no effect of draught animals.

Household Variables capturing Economic Status

Impact of economic status on the BMI of women in India is captured by the following variables: (log of) per capita annual household income, (log of) per capita monthly consumption, and categories formed on the basis of asset index. Though all three of them are likely to be closely related they have differential and significant effect on the well-being of women. Dahiya and Viswanathan (2015) using the same IHDS data for both rural and urban households finds that all the three variables influence women's BMI. IHDS provides information regarding some basic availability of assets in a household which can significantly ease the work of women and hence save a lot of energy. Also, income is a short term (transitory in nature) representation of economic well-being.Theassets/wealth is a long term counterpart as households accumulate assets over a period of time after saving from the income earned.

Per Capita Household Income: Per capita income will take into effect the resources available per person and reflects the *ex-ante*ability of the household to be able to spend on goods and services that would allow them to attain a healthy level of BMI. Larger the per capita income better would be the standard of living and hence the coefficient is expected to be positive. Natural log of per capita household income is used in the analysis.

Monthly Per Capita Consumption Expenditure (MPCE): Resources expended per person is the revealed standard of living and is more importantly inclusive of availability and accessibility to goods and services apart from reflecting the affordability and preference for goods and services particularly in remote rural areas. At lower levels of income, per capita income and consumption would be highly correlated as most of the income would be used up to meet current consumption (subsistence)needs; while it would be less correlated at higher levels of income depending on the household's preferences for current and future consumption. Thus, after controlling for per capita income we can expect this coefficient to be positively significant in influencing nutrition.

Asset (Wealth) Index*:* The asset or wealth index is estimated using principal component analysis by taking into account the basic household amenities like owned house, cycle, motor, sewing machine, wall clock, cot, chair, fan etc. The quality of the house such as *pucca* wall, roof etc. is also taken into consideration. The first principle component forms the index which is then categorized into five groups comprising the five quintiles and referred to as the poorest, poor, middle, rich, and richest asset groups (from lowest to highest quintile). The bottom most quintile is taken as the reference category for the econometric analysis and we expect the coefficients to be positive and significant with respect to this omitted category.

Table 7a shows the CED rates across three different quintile classifications based respectively on per capita income, monthly per capita consumption and assets mainly comprising of durable goods. The households are further segmented into non-farm and farm households within each of these economic status variables. First and foremost, the proportion of CED women across the different types of quintiles varies indicating that the distributions of these variables are different in that these three different economic status variables are not very strongly associated. For instance, the bottom most quintile has lower CED rates based on income when compared to that based on assets. Consequently, the gap in CED rates between bottom most and top most quintiles based on asset index are substantially higher. CED rates are by and large higher for women among farm households than that of non-farm households.

Table 7a: Percentage of Women with CED across Income, Consumption and Asset Quintile: Comparing Non-farm and Farm Households in Rural Areas.

Quintile Classes	Per capita Income Quintile		MPCE Quintile		Asset Quintile	
	Non-Farm Household	Farm Household	Non-Farm Household	Farm Household	Non-Farm Household	Farm Household
Q1	32.2	30.8	32.6	36.0	38.1	40.5
Q2	35.0	36.0	31.9	33.4	31.6	34.9
Q3	25.8	31.0	25.5	28.4	28.5	29.1
Q4	25.5	27.2	24.5	26.1	24.0	24.7
Q5	16.0	18.2	18.4	19.8	13.5	18.6
All	27.0	28.9	27.0	28.9	27.0	28.9

Note: The income quintile on the bases of per capita household income, MPCE quintiles on the bases of monthly per capita consumption expenditure (MPCE) and asset quintiles are on the basis of quintiles of asset index.

In order to understand whether the farm households and non-farm households are significantly different within a given quintile for each of the economic status variables, we estimate the following regression model.

$Y_i = \beta_1^{NF} + \delta_1 D_i + u_i$; For each of the five per capita income quintiles separately (2)

$Y_i = \beta_2^{NF} + \delta_2 D_i + u_i$; For each of the five per capita consumption expenditure (3)

$Y_i = \beta_3^{NF} + \delta_3 D_i + u_i$; For each of the five asset quintiles separately (4)

Each of the equations (2), (3), and (4) are estimated separately with two different dependent variables:

(2a) Y_i=1 if BMI<18.5 for the i^{th} woman or
=0 otherwise.
D_i= 1 if the woman is from a farm household or
=0 otherwise.

The same set of regression model is also estimated to compare the mean BMI rates. In this case D_i remains the same but the dependent variable is:

(2b) Y_i= BMI of the i^{th} woman

In each of these equations, δ_1, δ_2 and δ_3 represent the gap in CED rates are BMI between nonfarm and farm households with respect to per capita income quintiles, per capita consumption quintiles and wealth index respectively. Table 7b reports results where the dependent variable takes the value 1 if the woman has BMI below 18.5 and 0 otherwise to be interpreted as mean CED rates and Table 7c reports estimates with BMI as the dependent variable.Results in Table 7b show that CED rates are not significantly different between non-farm and farm households, as seen from the significance of the three different δ coefficients. Thus, in terms of undernourishment rates, women in non-farm households and farm households are by and large similar and the differences observed in the estimated coefficients is largely caused by women who do not have low BMI as shown in Table 7c. The gaps in mean BMI or the CED rates across quintiles as well as for the different type of quintiles varies which shows that income, consumption and wealth have different impact on BMI. Results in Table 7c shows that mean BMI rates are always lower for women in farm households irrespective of the quintile or the type of economic status quintile, barring the exception of first per capita income quintile and the second per capita consumption quintile. This is inferred based on the estimated δ coefficient being statistically insignificant at 1 percent level of significance.

Table 7b: Comparison of Average CED rates (percent) of Women in Non-Farm and Farm Households for Each Income, Consumption and Wealth Quintile

Per Capita Income Quintiles	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Non-Farm (β_1^{NF})	0.3226***	0.3501***	0.2585***	0.2548***	0.1597***
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	-0.0116	0.0102	0.0513***	0.0177	0.0224*
p-values	0.464	0.517	0.001	0.220	0.058
Farm ($\beta_1^F = \beta_1^{NF} + \delta_1$)	0.3110	0.3603	0.3098	0.2725	0.1821
Per Capita Consumption Quintiles	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Non-Farm (β_2^{NF})	0.3261***	0.3191***	0.2554***	0.2452***	0.1843***
p-values	0.000	0.000	0.000	0.000	0.000
δ_2	0.0342**	0.0153	0.0287*	0.0153	0.0161
p-values	0.026	0.321	0.053	0.276	0.201
Farm ($\beta_2^F = \beta_2^{NF} + \delta_2$)	0.3603	0.3344	0.2841	0.2605	0.2004
Wealth Quintiles	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Non-Farm (β_3^{NF})	0.3812***	0.3162***	0.2852***	0.2398***	0.135***
p-values	0.000	0.000	0.000	0.000	0.000
δ_3	0.024	0.0342**	0.0072	0.007	0.0507***
p-values	0.169	0.042	0.632	0.608	0.000
Farm ($\beta_3^F = \beta_3^{NF} + \delta_3$)	0.4052	0.3504	0.2924	0.2468	0.1857

Note: The coefficients are estimated based on equations (2), (3) and (4) respectively with dependent variable as in (2a).

Table 7c: Comparison of Average BMI (kg/m^2) of Women in Non-Farm and Farm households for Each Income, Consumption and Wealth Quintile

Per Capita Income Quintiles	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Non-Farm (β_1^{NF})	20.12^{***}	19.99^{***}	20.67^{***}	20.82^{***}	22.08^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	-0.03	-0.25^{**}	-0.55^{***}	-0.18^{*}	-0.52^{***}
p-values	0.741	0.011	0.000	0.087	0.000
Farm ($\beta_1^F = \beta_1^{NF} + \delta_1$)	20.08	19.75	20.12	20.64	21.56
Per Capita Consumption Quintiles	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Non-Farm (β_2^{NF})	20.05^{***}	19.97^{***}	20.72^{***}	21.11^{***}	22.06^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_2	-0.45^{***}	-0.03	-0.39^{***}	-0.47^{***}	-0.47^{***}
p-values	0.000	0.754	0.000	0.000	0.000
Farm ($\beta_2^F = \beta_2^{NF} + \delta_2$)	19.59	19.94	20.32	20.64	21.59
Wealth Quintiles	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Non-Farm (β_3^{NF})	19.51^{***}	20.05^{***}	20.59^{***}	20.91^{***}	22.46^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_3	-0.23^{**}	-0.21^{**}	-0.23^{**}	-0.29^{***}	-0.91^{***}
p-values	0.012	0.032	0.030	0.005	0.000
Farm ($\beta_3^F = \beta_3^{NF} + \delta_3$)	19.27	19.84	20.36	20.62	21.55

Note: Note: The coefficients are estimated based on equations (2), (3) and (4) respectively with dependent variable as in (2b).

Conceptually, wealth, income and consumption expenditure could all be highly correlated but this would be more so at a macro-level. At the micro (household) level the correlation among the three need not be strong as household preferences would vary. Income as such may not guarantee the rightful use of resources either due to lack of physical access to good quality diets in a sustained manner and/or socio-cultural and patriarchal influences could affect intra-household resource allocations and hence final consumption. Furthermore, in the absence of well-functioning financial markets for credit, savings and insurance there could be large differences across households in terms of wealth and income status. So even if one were to convert the income into quintiles it is not necessary that households across wealth and income quintiles would be very similarly distributed. This then enables us to study the impact of the income flow when compared to the stock of wealth on dietary diversity. Though consumption is also a flow variable it is smoother than income and hence its variability across households would be lower compared to income. This is because the food needs are limited and hence the rich and the poor may not be too different in their total consumption expenditures. It has been observed that mean consumption in the top quintile would be about 4-5 times higher than that in the bottom most while a similar comparison based on income could lead to 10-12 times higher average income in the top quintile compared to the bottom. We also expect level of current consumption to influence intake of various food items more directly and hence controlling for this and then assessing the income effect is of empirical interest.

Thus, we expect total consumption, income and wealth, to have different impact. Further an econometric model would allow us to measure the impact of each of these economic status variables by netting out the effect of the other two variables as well as other control variables in the model. So far, databases available in India have not collected all three types of measures for economic status and hence it has not been possible to assess their relevance empirically; and if relevant, the magnitude of its impact on the dietary intake would also be of interest. Given the way these variables are reported in the database, per capita income and per capita consumer expenditure are in logarithms while wealth effect is captured through categorical variables, a dummy variable for each category.

Sometimes the presence of other control variables like education can dampen the effect of economic variables or even make the coefficient of one of these variables insignificant. All of these are to be verified empirically and will be of interest to policy makers to understand the varying impacts. Most importantly the IHDS database enables us to understand such influences.

***Income Diversity*:**Since agriculture in India is largely dependent on natural conditions particularly rainfall, there is more uncertainty in the earnings from such activity. Thus, agricultural households may engage in other non-agricultural activities to smoothen their income flow throughout the year. While reviewing the literature on diversification among rural households in Sub-Saharan Africa, Ellis (1998), argues that removal of constraints for diversification through policy intervention is essential for such households. The 'diverse portfolio' of activities improves the living standards and help poor households to cope with distress in a better manner. Ecker*et al* (2012) finds that among rural Ghanaian households dietary diversity increases when the number of off-farm income sources increases. Thus, in this study also we use income diversity as an explanatory variable after controlling for per capita household income so as to understand that if households have other sources of income then it gives them the ability to cope with sudden shocks or prolonged distress in agriculture which is a common feature of Indian agriculture (Barrett *et al* 2001a and b; Himanshu*et al*, 2013).

The diversity in income earnings for a household would be possible only when there is scope to do so. That is, the household should have a larger number of adult members to contribute to this; there should be varied skill set among these adult household members; the local conditions should provide them the opportunity to earn incomes from different sources; and perhaps allow possibilities of migration and sending back remittances if there are members left behind.

The database provides information on the major sources of income categorized into: cultivation and allied agriculture activities (farming, livestock rearing, agricultural property), agricultural wage labour, non-agricultural wage labour, business income (artisan and independent work, petty shop, organized business and other trade), salary and professionals, and others (pension, rent and others). One regressor for each income share from different sources (excluding 'others') is used in the econometric model so as to enable a comparison of the relative importance of agricultural income vis-à-vis other income sources.

Alternatively, Income Diversity Index (IDI) defined as $1-\sum_{i=1}^{k} y_i^2$ where y_i is the share of income from the i^{th} source in the total income as reported by that household is taken as the explanatory variable. This is defined in the same manner as production diversity index, mentioned earlier and the higher the value of IDI higher is the income diversity. The regression results were founds to be better for the former set of regressors (share of income source) rather than for IDI and hence these have been reported in the results. The larger the income diversity, the income earnings are expected to be smoothened through the year so that a lean agricultural period is less likely to affect food consumption as well as other expenditures including that on health. Hence one expects income diversity after controlling for the level of income to have a positive effect on dietary diversity, CED rates or BMI.

We observe that farm households have more diversified income sources compared to non-farm households as shown in Table 8 below perhaps indicating the need to be more diversified given the nature of occupation that they pursue as mentioned in the discussions above.

Dietary Variables

Dietary Diversity Index: Consumption of certain food items like cereals is available in quantities but for many other food items either the quantity information is not available or the food group is too broad. For instance, different types of pulses (or meat, egg and fish) are reported as single food group. Consequently the conversion of such broad groups of food intakes into their macro and micro nutrient content is not possible as each of these food items have varied amount and frequency of consumption but also their nutrient content varies substantially across nutrient types. Kennedy et. al (2007) show that dietary diversity is correlated with calorie adequacy. Hence expenditure on various food items are used to calculate dietary diversity. This index is calculated in the same manner as other 'diversity' indices mentioned above. For a particular household, Dietary Diversity Index (DDI) $= 1 - \sum_{i=1}^{k} d_i^2$ where d_i is the share of expenditure from the i^{th} food item in the total household food expenditure. The data set has collected information on expenditure for 13 broad groups of food items. The value of the above expression lies between 0 and 1 and higher the value of this index, the higher is the diversity in food items consumed by the household.

Table 8 shows that dietary diversity index does not differ much between non-farm and farm households and only increases very marginally towards the upper BMI quintiles. Compared to this, cereal expenditure share shows more variability across the BMI quintiles for both farm and non-farm households. As for mean number of food items consumed it is marginally higher for farm households than for non-farm households and also the top most quintile of BMI indicates higher number than the lower quintiles among the farm households. Perhaps a higher variation in these different indices across BMI quintiles could have been observed if the food commodity groups had been available for a larger number of disaggregated food items. Given that cereal expenditure share varies more across BMI quintiles, we also use this as a measure of dietary diversity in the analysis. It has been argued by Jensen and Miller (2010) that cereal expenditure share is a better measure of dietary diversity.

Table 8: Mean of Income Diversity Index and Dietary Diversity Index across BMI quintiles

BMI Quintiles	Income Diversity Index		Dietary Diversity Index		Cereal Expenditure Share		Mean number of Food Items	
	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld
Q1	0.21	0.40	0.81	0.81	38.8	39.0	8.6	8.7
Q2	0.21	0.40	0.81	0.81	38.3	38.5	8.4	8.8
Q3	0.19	0.38	0.82	0.82	36.8	37.8	8.5	8.8
Q4	0.18	0.38	0.82	0.82	35.4	35.7	8.6	8.9
Q5	0.17	0.34	0.83	0.84	31.7	32.5	8.5	9.1
All	0.19	0.38	0.82	0.82	36.0	36.8	8.5	8.8

One would expect women to have a higher average BMI if they belonged to households that consumed a more diversified diet and hence dietary diversity index as defined above could be expected to have a positive relationship with BMI. However, high levels of BMI leading to overweight and obesity due to inappropriate diet and one might expect this coefficient to be smaller in magnitude for the uppermost quantile of BMI in the quantile regression model compared to other quantiles. Given that not many women are overweight and obese, and also that this is a household indicator of dietary diversity, there may be some variations in the expected significance and magnitude of the estimated coefficient compared to what is hypothesized here. In such an analysis linking household dietary diversity to individual BMI may not be the ideal approach. A better measure of dietary diversity should be based on individual's dietary pattern so that its direct effect on BMI could be assessed. Bhagowalia*et al* (2012a) use the number of food items consumed or the share of cereals versus non-cereals as a measure of household dietary diversity on child's nutritional status under the assumption that household's dietary diversity would also reflect in a child's intake of diverse diet. We also make a similar assumption of trickle down so that a higher dietary diversity in a household would have a positive impact on the individual's BMI. However, this assumption can be invalidated in the presence of gender bias and under some resource constraint there is likely to lead to unequal distribution of nutritious food between members (male and female or young and old) of the household.

Household Level Variables Capturing Social and Demographic Features

***Women's Status*:** Similar to the asset index, women's autonomy index is also estimated using several questions relating to: mobility like permission to visit the grocery store, hospital or her natal home; decision-making regarding day to day affairs as well as decision on child's education and marriage; socio-cultural practices like purdah or eating habit (women eat after men eat); share in ownership of house/land or possession of bank account. Lower quintiles allude to lower levels of autonomy.

Table 9a shows that though CED rates decline with the women's autonomy quintiles, the lowest autonomy quintile shows a lower CED rate among non-farm and farm households and is a little unexpected[9]. Similar is the case with mean BMI.

Table 9a: CED Rates, Mean and Standard Deviation of BMI Across Quintiles of Women's Autonomy Index

Autonomy Quintiles	CED rates		Mean BMI		Standard Deviation of BMI	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Bottom 20 percent	22.0	28.2	20.7	20.0	3.18	2.94
20-40 percent	33.8	33.1	20.1	20.1	2.99	3.06
40-60 percent	24.2	28.1	20.7	20.4	3.06	3.09
60-80 percent	23.6	26.7	21.1	20.5	3.41	3.21
Top 20 percent	27.7	27.2	20.9	20.7	3.57	3.32
All	27.0	28.9	20.7	20.4	3.31	3.17

However, when some of the variables that constitute this index are used separately we find a statistically significant influence on BMI. In particular three different binary variables: whether there is permission to go to the grocery store (more autonomy) or not; whether women in the household do not practice purdah (more autonomy) or not; whether the women eat along with men (more autonomy) or after them. The worse off category in terms of autonomy is the reference category for the dummy variable.Table 9b shows that in most of the groups, about two-thirds are in the 'less' autonomy category while the CED rates are not at all different between the 'less' and 'more' autonomy groups except in the case of *purdah*.

[9]We found that the autonomy index did not have a smooth distribution and the quintiles could not be easily formed particularly at the lower end.

Table 9b: Distribution of Women CED Rates AcrossSpecific Autonomy Variables

Autonomy Variable	Distribution		CED Rates	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Not allowed to go to Grocery store	59.5	66.4	25.8	29.3
Allowed to go to Grocery store	40.5	33.6	28.8	28.2
Practice Purdah	53.5	66.5	28.7	30.0
No Purdah	46.5	33.6	25.1	26.9
Men eat first	50.7	60.3	27.2	29.5
Men and women eat together	49.3	39.7	26.9	28.1

***Highest Education level of an adult household member*:** Highest education level of an adult household member is used as an indicator that would influence awareness towards dietary habits directly and also hygienic habits and health seeking behavior,whichis known to influence nutrition outcomes indirectly. Results in Table 10a are estimated coefficients from a linear regression model of dietary diversity, CED, BMI with education levels as dummy variables, respectively. The results show that highest education level of an adult member does make a significant difference to the nutritional intake as well nutritional outcome.

Table 10a: Estimates for Dietary Diversity, CED Rates and BMI Across Education of the Highest Educated Member of the Household

	Dietary Diversity Index		CED (percent)		BMI (kg/m^2)	
Estimated Coefficients						
Adult's Education Level	Coeffs	p-value	Coeffs	p-value	Coeffs	p-value
Not literate (β_0)	0.801***	0.000	32.7***	0.000	20.0***	0.000
Primary+Middle (β_1)	0.812***	0.000	30.8***	0.000	20.3***	0.000
Secondary (β_2)	0.834***	0.000	24.3***	0.000	20.9***	0.000
Higher Secondary (β_3)	0.844***	0.000	22.1***	0.000	21.1***	0.000
Graduate (β_4)	0.853***	0.000	19.8***	0.000	21.7***	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	48.3***	0.000	4.91**	0.026	24.7***	0.000
H_0: $\beta_1=\beta_2$, H_1: $\beta_1\neq\beta_2$	190.0***	0.000	51.55***	0.000	78.8***	0.000
H_0: $\beta_2=\beta_3$, H_1: $\beta_2\neq\beta_3$	17.8***	0.000	3.06***	0.080	6.3***	0.000
H_0: $\beta_3=\beta_4$, H_1: $\beta_3\neq\beta_4$	11.9***	0.000	2.51	0.113	28.5***	0.000

Table 10b presents the mean of these variables for non-farm and farm households separately. As for dietary diversity one observed that the farm households at lower levels of education (not literate and primary & middle) show lower diversity as well as higher CED rates and lower average BMI. However, CED rates are higher and mean BMI lower among farm households irrespective of level of education. This may be due to higher level of physical activity which leads to higher expenditure of energy even though the dietary diversity is similar for women in such households (Pacey and Payne, 1985).

Table 10b: Comparison of Dietary Diversity, CED rates and BMI across Education of the Highest Educated Member of the Household for Non-Farm and Farm Households

Highest Education Level of an Adult in the Household	Dietary Diversity Index		CED rates		BMI	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Not literate	0.803	0.799	32.8	32.5	20.1	19.9
Primary+Middle	0.815	0.809	28.8	32.5	20.5	20.2
Secondary	0.834	0.834	22.0	26.0	21.2	20.6
Higher Secondary	0.845	0.843	18.8	24.1	21.6	20.8
Graduate	0.855	0.852	15.3	22.2	22.4	21.3
All	0.820	0.821	27.0	28.9	20.7	20.4

In Table 10c a linear regression model is estimated for each of the education level in order to compare the mean dietary diversity across non-farm and farm households. As expected based on the results from Table 10b, the estimated coefficient for the gap between the two types of households is statistically significant only for the two lower education groups.

Table 10c: Testing for Difference in Dietary Diversity Index between Non-farm and Farm Household within Each Education Level

Dietary Diversity Index	Highest Education Level of an Adult in the Household				
	Illiterate	Primary+ Middle	Secondary	Higher Secondary	Graduate
Non-Farm (β_1^{NF})	0.803^{***}	0.814^{***}	0.834^{***}	0.844^{***}	0.855^{***}
p-values	0.000	0.000	0.000	0.000	0.000
Gap between Non-Farm and Farm (δ_1)	-0.0045^{*}	-0.0056^{***}	0.0002	-0.0019	-0.0032
p-values	0.099	0.009	0.909	0.554	0.254
Farm ($\beta_1^F = \beta_1^{NF} + \delta_1$)	0.7987	0.8092	0.8342	0.8429	0.8517

Among farm households, Table 10d shows the mean and standard deviation of production diversity indices based on area and value of the crops across education levels. It can be seen that mean increases and standard deviation decreases with education level. Further the table also shows that the share from home grown decreases with education levels while the share from sale increases. It is also to be noted that these two shares do not add up to 100 and the remaining share is for the landlord which decreases with education level. The more educated among the farm households have a lower share of agricultural income in total household income indicating that higher income diversity could also be leading to higher dietary diversity as income flow through the year is expected to be smooth.

Table 10d: Production Diversity, Area Under Cultivation and Other Agricultural Variables Across Education Level for Farm Households

		PDI (Area)	PDI (Value)	Share of own consumption[3]	Share of sale in market[3]	Area under cultivation (acres)	Share of agricultural income[4]
Not literate	Mean	0.420	0.373	0.661	0.275	31.826	0.692
	sd	0.280	0.278	0.353	0.348	41.775	0.340
Primary+ Middle	Mean	0.447	0.388	0.629	0.327	41.062	0.701
	sd	0.271	0.266	0.358	0.360	62.146	0.345
Secondary	Mean	0.469	0.413	0.578	0.390	52.276	0.656
	sd	0.272	0.274	0.366	0.372	100.267	0.365
Higher Secondary	Mean	0.496	0.442	0.577	0.406	62.416	0.609
	sd	0.255	0.276	0.365	0.367	91.536	0.361
Graduate	Mean	0.473	0.413	0.561	0.424	71.576	0.514
	sd	0.274	0.272	0.371	0.371	100.700	0.376
Total	Mean	0.454	0.399	0.611	0.349	47.341	0.658
	sd	0.273	0.273	0.362	0.366	78.304	0.359

Note: (1) sd- standard deviation; (2) PDI: Production diversity index; (3) Proportion of production that is used for own consumption and sold in the market respectively; (4) Proportion of household income from agriculture and allied activities.

***Religion**:* There are four religion dummy variables – Hindu, Muslim, Christian and Other Religions with 'Hindu' taken as the reference category in the econometric estimations. This variable is included to capture another aspect of dietary diversity that is the consumption of plant based food in comparison to animal based food products. The dietary diversity variable does not capture this feature adequately in our data set and we feature this in indirectly as well through the religion variable. Though there is information in the data on consumption of different food items but many of them like meat, egg, chicken and fish are all aggregated into a single category. This makes conversion of food items into its nutrient content difficult as households report the consumption in value terms rather in quantity. Table 11a shows that there are differences in mean values of dietary diversity index, CED rates and mean BMI across most religious groups. Dietary diversity is not significantly (statistically) different between Hindus and Christians while CED rates and mean BMI are not different between Muslims and other religions.

Table 11a: Comparison of Dietary Diversity Index, CED Rates and BMI Across Religious Groups

	Dietary Diversity Index		**CED (percent)**		**BMI (kg/m^2)**	
Estimated Coefficients						
Religion	Coeffs	p-value	Coeffs	p-value	Coeffs	p-value
Hindus (β_0)	0.821***	0.000	29.3***	0.000	20.4***	0.000
Muslim (β_1)	0.825***	0.000	23.3***	0.000	21.1***	0.000
Christian (β_2)	0.814***	0.000	12.1***	0.000	22.0***	0.000
Other Religions (β_3)	0.807***	0.000	21.0***	0.000	21.3***	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	5.4***	0.0201	32.1***	0.000	85.2***	0.000
H_0: $\beta_0=\beta_2$, H_1: $\beta_0\neq\beta_2$	2.15	0.1422	49.6***	0.000	79.1***	0.000
H_0: $\beta_0=\beta_3$, H_1: $\beta_0\neq\beta_3$	17.7***	0.000	23.2***	0.000	51.1***	0.000
H_0: $\beta_1=\beta_3$, H_1: $\beta_1\neq\beta_3$	24.5***	0.000	1.34	0.247	1.60	0.205

It is known that Hindus may have a more predominant vegetarian diet than Muslims and Christian in India. Animal based protein intake is known to have a better impact on nutritional status and therefore, one could expect better nutrition status among Muslim and Christian women than their Hindu counterparts as on an average Hindus consume more vegetarian food items[10]. Table 11b shows that the food expenditure share is higher among Muslims and lower among Christians compared to Hindus. This could show a somewhat lower level of diversification to non-food among Muslims. The cereal expenditure share in total food expenditure varies marginally across these groups. As was envisaged, the proportion of non-vegetarian food items is higher among Muslims and even higher among Christians while share of milk is higher among Hindus and 'Others'. There is not much difference in fruits and vegetables shares (pulses and oils, not reported here) across religious groups.

[10] Note that apart from dietary habits, there could be other reasons for BMI difference across religious groups. For instance Geruso and Spears (2014)argues that sanitation is worse among Hindus hamlets than among Muslims.

Table 11b: Expenditure Share of Different Food Items Across Religious Groups

		Food[1]	Cereals	Non-vegetarian	Milk	Fruits	Vegetables
Hindu	Mean	55.6	36.5	6.7	12.3	2.2	11.7
	sd	15.64	14.24	7.18	13.21	3.12	6.53
Muslim	Mean	60.3	37.9	11.9	8.3	1.8	11.3
	sd	15.58	12.87	7.95	9.99	2.81	5.61
Christian	Mean	49.5	34.2	14.5	8.5	2.7	11.4
	sd	16.03	12.65	8.98	9.04	3.44	6.52
Others	Mean	55.9	33.8	7.3	12.9	1.9	12.3
	sd	15.45	15.19	8.20	15.21	2.74	5.78
Total	Mean	56.0	36.5	7.4	11.8	2.2	11.7
	sd	15.72	14.13	7.57	12.99	3.09	6.42

Note: (1) Food Expenditure is as a per cent of Total expenditure while all other items are as a per cent of total food expenditure.

Of course, the frequency and adequacy of diets is also important to consider but one would expect lower frequency and per capita consumption to be correlated with economic status of the household capturing affordability and also the prosperity of a region which would improve regular accessibility. Since economic status is already controlled for using several other variables and also regional (state) dummy variables are used which would in a very broad sense control for accessibility we expect these coefficients to be a net effect of all these aspects. However, if such dietary habits are not captured latently by the religion dummy variable one can expect the coefficients to be not significantly different statistically from each other.

Table11c below shows that mean dietary diversity index is lower among non-farm households compared to farm households among Hindus and Muslims. In comparison to this, CED rates are highest among Hindu women and that Muslim women are better off among both non-farm and farm households. Among Christians one observes higher CED rates among non-farm households than farm households. For mean BMI, there is no significant difference between non-farm and farm for Hindus and Muslims.

Table 11c: Distribution of Women and CED Rates Across Religious Groups for Non-farm and Farm Households

Religious Groups	Distribution of women		Dietary Diversity Index		CED Rates		Mean BMI	
	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld
Hindu	81.9	86.3	0.819	0.822	28.3	30.1	20.6	20.3
Muslim	12.0	9.0	0.821	0.830	22.8	24.0	21.1	21.1
Christian	2.4	1.3	0.821	0.803	16.4	5.3	21.5	22.7
Others	3.8	3.6	0.832	0.785	19.2	22.7	21.6	21.0

Table 11d below provides statistical tests to compare the non-farm household with farm household for each of the religious groups as was done for income status using equation 2. Unlike in the case of education, the farm households have a more diversified diet, lower CED rates and higher mean BMI for Hindus and Muslims. With a far lower share of household and women for Christians and 'Others', the farm households have a lower nutritional status compared to non-farm households.

Table 11d: Comparing Non-farm with Farm Household for Each Religious Group

	Hindu	Muslim	Christian	Others	All
Dietary Diversity Index					
β_1^{NF}	0.819^{***}	0.821^{***}	0.821^{***}	0.832^{***}	0.820^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	0.003^{*}	0.009^{***}	-0.017^{**}	-0.047^{***}	0.001
p-values	0.047	0.006	0.023	0.000	0.376
$\beta_1^F = \beta_1^{NF} + \delta_1$	0.822	0.830	0.803	0.785	0.821
CED rates					
β_1^{NF}	28.3^{***}	22.8^{***}	16.4^{***}	19.2^{***}	27.0^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	1.80^{**}	1.10	-11.0^{***}	3.5	2.0^{***}
p-values	0.013	0.575	0.000	0.181	0.003
$\beta_1^F = \beta_1^{NF} + \delta_1$	30.2	23.9	5.3	22.7	29.0
BMI					
β_1^{NF}	20.6^{***}	21.1^{***}	21.5^{***}	21.6^{***}	20.7^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	-0.332^{***}	-0.046	1.23^{***}	-0.655^{***}	-0.327^{***}
p-values	0.000	0.770	0.000	0.006	0.000
$\beta_1^F = \beta_1^{NF} + \delta_1$	20.3	21.1	22.7	21.0	20.4

Caste: Indian society has been divided into various castes (*varna* system of the Hindus) on the basis of their occupation since ancient times. Relegation of menial jobs to some social groups with limited or no access to productive resources and subsequently persistent discrimination in several other domains of social and economic status has created high socio-economic disparity among these groups in the Indian society. This could reflect in their low BMI and high percentage of people suffering from CED. Other Backward Castes (OBC) dominate among women in farm households. CED rates are about 10-15percentage points higher among scheduled castes (SC) and scheduled tribes (ST) households and consequently mean BMI is also lower among them as shown in Tables 12a and 12b below. The Upper caste Hindus (UCH) have far lower rates of CEd and consequently higher mean BMI compared to all other castes. Given the larger variation in CED rates across each of these caste groups one would expect significant impact of this coefficient on dietary diversity as well as BMI and hence this is included in the diet equation as well as the CED/BMI equations.

Table 12a: Comparison of Dietary Diversity Index, CED rates and BMI across Caste Groups

	Dietary Diversity Index		CED rates (%)		BMI (kg/m^2)	
Caste Groups	Coeffs	p-value	Coeffs	p-value	Coeffs	p-value
UCH (β_0)	0.854***	0.000	18.2***	0.000	21.4***	0.000
OBC (β_1)	0.826***	0.000	27.0***	0.000	20.6***	0.000
SC(β_2)	0.811***	0.000	33.6***	0.000	19.9***	0.000
ST (β_3)	0.766***	0.000	35.6***	0.000	19.7***	0.000
Others (β_4)	0.838***	0.000	22.4***	0.000	21.2***	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	86.0***	0.000	27.7***	0.000	42.5***	0.000
H_0: $\beta_0=\beta_4$, H_1: $\beta_0\neq\beta_4$	24.9***	0.000	5.87**	0.015	1.9	0.164
H_0: $\beta_1=\beta_4$, H_1: $\beta_1\neq\beta_4$	61.5***	0.000	27.9***	0.000	95.6***	0.000
H_0: $\beta_2=\beta_3$, H_1: $\beta_2\neq\beta_3$	109.4***	0.000	63.2***	0.000	136.1***	0.000

Tables 12b and 12c show that dietary diversity is better off for farm households among upper caste Hindus and ‘others’ while the same does not hold for the other groups. Focusing on the socially disadvantaged groups, the result is mixed. For some groups the farm households are worse off in terms of dietary diversity or CED rates while for others there is no difference between non-farm and farm households. In order to better understand how this plays out, one has to look at the coefficients in a linear regression where other factors like education, economic status and access to basic amenities are controlled for.

Table 12b: Distribution of Women and CED Rates Across Social Groups

Caste Groups	Distribution of women		Dietary Diversity Index		CED Rates		Mean BMI	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Upper Caste Hindus	3.0	5.0	0.847	0.857	19.6	17.4	21.4	21.4
OBC	38.5	44.2	0.829	0.824	23.7	29.4	21.1	20.3
SC	33.4	17.2	0.811	0.810	33.2	34.1	20.0	19.8
ST	7.6	10.4	0.783	0.756	35.4	35.6	19.9	19.7
Others	17.5	23.3	0.827	0.845	20.3	23.8	21.5	21.1

Table 12c: Comparing Non-farm with Farm Household for Each Social Group

	Upper Caste Hindus	Other Backward Classes	Scheduled Castes	Scheduled Tribes	Other Castes
Dietary Diversity Index					
Non-Farm (β_1^{NF})	0.847^{***}	0.829^{***}	0.811^{***}	0.783^{***}	0.827^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	0.010^{***}	-0.006^{***}	-0.001	-0.027^{***}	0.018^{***}
p-values	0.008	0.002	0.622	0.000	0.000
Farm ($\beta_1^F = \beta_1^{NF} + \delta_1$)	0.857	0.824	0.810	0.756	0.845
CED rates					
Non-Farm (β_1^{NF})	19.6^{***}	23.7^{***}	33.2^{***}	35.4^{***}	20.3^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	-2.15	5.70^{***}	1.03	0.31	3.50^{***}
p-values	0.461	0.000	0.487	0.890	0.006
Farm ($\beta_1^F = \beta_1^{NF} + \delta_1$)	17.4	29.4	34.2	35.7	23.8
BMI					
Non-Farm (β_1^{NF})	21.35^{***}	21.06^{***}	20.05^{***}	19.86^{***}	21.49^{***}
p-values	0.000	0.000	0.000	0.000	0.000
δ_1	0.10	-0.75^{***}	-0.28^{***}	-0.18	-0.40^{***}
p-values	0.702	0.000	0.003	0.161	0.000
Farm ($\beta_1^F = \beta_1^{NF} + \delta_1$)	21.45	20.31	19.77	19.68	21.08

Household Composition: This variable is expected to capture two aspects relating to nutrition. One, is the impact on the effort of women due to childcare so that women in households with a higher proportion of children than adults may to expend more energy and hence a lower BMI on average after controlling for other factors. The second feature would be the impact of dietary composition arising out of differences in sharing of resources particularly food items so that we expect a household with a higher proportion of child compared to adults would perhaps have a higher share of say, milk and milk products. The household composition variables relate to the proportion of people in the following age groups in a household: 0 to 4 years of age, 5 to 14 years of age, 15 to 60 years of age, and above 60 years of age. Since these proportions add up to one, the first group is excluded and is taken as equivalent to the reference category as would be in the case of categorical variables.

Household Size: It is important to control for household size while the effect of household composition is analyzed, as a four member household can have three adults and one child or two adults and one child which could make a difference to the women's BMI status. Thus, household size is also included in the model but we expect it to be insignificant for most of quantiles as household size is usually higher among economically worse-off households.

Basic Amenities

Water, sanitation, electricity and cooking fuel that signify some very basic needs of civilized social life are being considered as basic amenities. These have strong influences on health in terms of causing short term illnesses like diarrhea and fever or long term impacts on respiratory and immune systems which in turn affect the absorption of the nutrient intakes thereby affecting the overall nutrition status that is, BMI.

Categorical (dummy) variables that indicate use of consumption of purified water for drinking or not; use of different types of sanitation facility; access to electricity or not and use of LPG/kerosene as primary (clean) cooking fuel or not is included in the econometric estimations. We may expect positive association between the presence of better amenities and hence a strong correlation among them and hence not all the coefficients would simultaneously be statistically significant when included in the econometric model. However, the access, timely and sustained provision as well as its usage would depend both on state's role as well as the household's preferences. For instance, despite the presence of toilets in the house, there is a preference to open defecate as it is not considered 'appropriate' to defecate within the household premises by some (Geruso and Spears, 2014).On the other hand if there is no regular supply of water for the toilets then it would automatically restrict the usage. Similarly, households may possess LPG connection and stoves but it may not be delivered timely and regularly due to poor distribution networks so that the households may be forced to supplement the cooking fuel with less cleaner sources. So it needs to be empirically assessed to understand the impact on health.

Quality of drinking water: Source of drinking water can often capture the effect of quality of water. As shown in Table 13a below, we observe that women in farm households are distributed primarily (about 70 percent) between those with piped water or tube-well as the source of drinking water while the non-farm households report hand-pump as the predominant source of water. Among farm households, CED rates are not very different across sources of drinking water except that between tube-well (18.2 percent) and hand-pump (33.4 percent). This gap in CED rates is not that large in the non-farm households and this could be because the presence of a tube-well in a farm household could be for irrigation purposes as well and hence signifies wealth effect and lesser drudgery of hand-pumping water thereby leading to better impact on BMI.

Table 13b shows that CED rates are not different between piped water, well and other sources. It is indeed surprising to find that women with piped water as the source have higher CED rates, as piped water is not only supposed to be least contaminated but also these women need not have to undertake more effort to fetch the water[11]. Perhaps the supply of piped water is not of good quality and has higher adverse health impacts as observed in Klasen et. al (2012) recently in comparison to an earlier study by Jalan and Ravallion (2003) which finds lower rates of diarrhea among children in rural areas. For rural areas the hand pump seems to have a better impact on CED rates and BMI as shown in Tables 13a and 13b.

[11]The piped water or for that matter from any other source was further combined with the amount of distance travelled to fetch the water. But this also did not make significant difference in the BMI variations or in the regression results.

Table 13a: Distribution of Women and CED Rates across Drinking Water Sources and Quality of Water

Water Source/Water Purification	Distribution of Women (percent)			CED Rates (percent)		
	Non-Farm Hhld	Farm Hhld	All	Non-Farm Hhld	Farm Hhld	All
Source of Drinking Water						
Piped	33.4	22.4	27.5	24.8	28.0	26.2
Tube-well	13.1	13.5	13.3	18.2	25.0	22.0
Hand-pump	36.1	42.7	39.5	33.3	31.4	32.2
Well	15.8	18.4	17.2	25.1	27.5	26.5
Others	1.8	3.1	2.5	24.9	28.8	27.5
All	100.0	100.0	100.0	27.0	28.9	28.1
Water Consumed After Treatment or not						
No	84.3	87.4	86.0	29.3	30.9	30.2
Yes	15.7	12.7	14.0	14.5	15.7	15.1
All	100.0	100.0	100.0	27.0	28.9	28.1

Table 13b: Comparing CED Rates and BMI AcrossSources of Drinking Water

	CED (percent)		BMI (kg/m^2)	
Estimated Coefficients				
Source of Drinking Water	Coefficients	p-value	Coefficients	p-value
Piped (β_0)	24.8^{***}	0.000	20.9^{***}	0.000
Tube-well (β_1)	18.2^{***}	0.000	20.8^{***}	0.000
Hand-pump (β_2)	33.3^{***}	0.000	20.2^{***}	0.000
Well (β_3)	25.1^{***}	0.000	20.6^{***}	0.000
Others (β_4)	25.2^{***}	0.000	20.5^{***}	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	14.47^{***}	0.000	0.11	0.738
H_0: $\beta_0=\beta_2$, H_1: $\beta_0\neq\beta_2$	56.36^{***}	0.000	134.16^{***}	0.000
H_0: $\beta_0=\beta_3$, H_1: $\beta_0\neq\beta_3$	0.12	0.731	18.97^{***}	0.000
H_0: $\beta_0=\beta_4$, H_1: $\beta_0\neq\beta_4$	0.49	0.484	5.76^{**}	0.016
H_0: $\beta_1=\beta_2$, H_1: $\beta_1\neq\beta_2$	97.78^{***}	0.000	76.02^{***}	0.000

In the regression analysis with other regressors, source of water did not have an impact but variables that capture if the drinking water is treated prior to its consumption was used as a way to understand the relevance of quality of water in improving BMI. Treated water would include filtration of water or boiling. If water is treated before drinking so that there are noticeable impacts on reducing infections and thereby illnesses like diarrhea or cough and cold then it would affect BMI in the short-run. About 85percent of the women belong to households that did not treat water and the CED rates among such women doubles when compared to those who consume treated water as shown in Table 13a.

Sanitation facility: Having proper sanitation facility at home is more hygienic and reduces the chances of falling ill frequently. The data reports toilet types in the following four categories: open defecation, traditional toilet, pit latrines and flush toilets and these have been used as dummy variables. As Jose and Navaneetham (2010) show that CED rates are higher among women who do not have access to any type of toilet facility, we include categories of different types of toilet facility as dummy regressors. Open defecation has also been shown to have a significant impact on underweight and stunting among children (Hungama report[12] or Spears and Lamba, 2013).Access to no toilet facility is the reference category in the regression model to see if BMI on average is lower among such households and by how much after controlling for other variables. We also form different types of toilet facility with the flush toilet considered as the cleanest type to see if there any variations in CED rates across these categories.

Table 14a below shows that open defecation is highly predominant with about 70 percent of the women in non-farm households and 75 percent of them among farm households report it. There are very few studies that have been able to bring about a clearer explanation on why lack of access to toilet would affect women's BMI so dramatically[13]. The CED rates are double that among women in such households compared to any other type of toilet facility available as shown in Table 14b. One would have expected women in households with flush toilets to have the lowest CED rates as this is the most hygienic. One possibility is that if there is no regular supply of water to the toilets or there are particular cultural inhibitions in using toilets within the premise of

[12] See www.naandi.org and also www.hungamaforchange.org for the report. Studies by Geruso and Spears (2014) recommend use of open defecation prevalence at the village level showing in the econometric specifications as having an impact on child's undernutrition rather than whether the practice is at the household level. This is because according to them it is other people's germs that are harmful and hence children in villages that show a higher prevalence of open defecation show a higher level of stunting. In our study, we could not find the village level variable to be significant in the econometric estimations while the household level variable does show significant coefficients and hence have retained the same.

[13] A recent study conducted in slums of Delhi indicates that due to the abdominal conditions and very limited availability of public toilets, women avoid toilet usage as and when it needs to be (Sharma, *et al*, 2015). In order to not feel the need to frequent the toilets, women tend to drink less water and eat less food particularly in the nights. Clearly this would have immediate effect on their BMI. There could also be health implications due to living in unhygienic conditions as well as from menstrual hygiene which are not discussed in this context in many studies. Lack of access to toilets has a very strong bearing in the context of school dropouts among adolescent girls (http://infochangeindia.org/women/news/lack-of-sanitary-protection-causes-23-of-girls-to-drop-out-of-school.html)

the house then perhaps the usage is limited and hence the effect is not visible. Many of such details were not available in the database and hence could not be captured in the analysis. What is perhaps important to note is that access to any kind of toilet is way better than none. Bhagowalia*et al* (2012a) also finds a mixed result on the type of toilet facility but there is a clear adverse impact on child undernutrition among those households who do not have access to any form of toilet facility.

Table 14a: Distribution of Women and CED Rates across Type of Toilet Facility Used

Toilet type used	Distribution of Women (percent)			CED Rates (percent)		
	Non-Farm Hhld	Farm Hhld	All	Non-Farm Hhld	Farm Hhld	All
None,open fields	69.7	75.2	72.7	32.2	33.1	32.7
Traditional latrine	12.4	10.0	11.1	15.0	15.9	15.4
VIP latrine	5.0	4.3	4.6	14.0	13.8	13.9
Flush toilet	12.9	10.6	11.7	15.5	18.1	16.8
All	100.0	100.0	100.0	27.0	28.9	28.1

Table 14b Comparison of CED Rate and BMI between Households with Different Types of Sanitation Facility

	CED (percent)		BMI (kg/m^2)	
Estimated Coefficients				
Sanitation Type	Coeffs	p-value	Coeffs	p-value
None, open fields(β_0)	32.8^{***}	0.000	20.0^{***}	0.000
Traditional latrine(β_1)	15.4^{***}	0.000	21.8^{***}	0.000
VIP latrine(β_2)	13.9^{***}	0.000	22.0^{***}	0.000
Flush toilet (β_3)	16.8^{***}	0.000	22.0^{***}	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	281.1^{***}	0.000	573.2^{***}	0.000
H_0: $\beta_0=\beta_2$, H_1: $\beta_0\neq\beta_2$	151.1^{***}	0.000	327.1^{***}	0.000
H_0: $\beta_0=\beta_3$, H_1: $\beta_0\neq\beta_3$	247.6^{***}	0.000	751.3^{***}	0.000
H_0: $\beta_1=\beta_2$, H_1: $\beta_1\neq\beta_2$	0.78	0.377	2.97^{*}	0.085
H_0: $\beta_1=\beta_3$, H_1: $\beta_1\neq\beta_3$	1.10	0.294	4.93^{**}	0.026
H_0: $\beta_2=\beta_3$, H_1: $\beta_2\neq\beta_3$	2.86^{*}	0.091	0.001	0.967

Electricity: Access to electricity is another basic amenity which, one the one hand signifies a better quality of life and on the other hand could lead to increased use of electrical gadgets that would reduce women's household drudgery. Electricity has reached the majority of towns and villages in India and its absence signifies severe poverty for a household. Rural areas being more poverty stricken, affordability and access to gadgets may be somewhat limited unless there are government programs like in the state of Tamil Nadu where electrical gadgets like fan, mixer and grinder have been given to households with BPL cards. However, possession of gadgets may not adequately impact lessening of drudgery unless its usage has been regular due to continuous access to electricity. IHDS also collected data on average number of hours a household normally receives electricity if they do at all. This additional information is usually not available in databases of similar nature. So an attempt was also made to compare the BMI across households across average number of hours of electricity received in a day.

Average hours of electricity received per day as reported by the household has been grouped into 6-hourly categories (0-6 hrs, 7-12 hrs, 13-18 hrs, 19-24 hrs) and the results in variations of BMI are reported in Table 15 below. About 60-65 percent of the women report access to electricity and those who have access have lower CED rates with the gap of about 10 percentage points. This gap though substantially large is lower than that for lack of access to quality of water or sanitation. A larger proportion of the women report 0-6 hours as the average duration of daily availability, while about 25 percent in the non-farm households and about 15 percent in the farm households report 19-24 hours. The CED rates are higher in the lowest availability category and for the remaining we observe that there is no clear gradation. Consequently, we find that access/non-access to electricity made the difference in BMI while a further classification into duration of availability did not have the impact in the regression analysis and hence the former is only retained in the final results.

Table 15: Distribution of Women and CED Rates Across Electricity Usage

Availability of Electricity	Distribution of Women (percent)			CED Rates (percent)		
	Non-Farm Hhld	Farm Hhld	All	Non-Farm Hhld	Farm Hhld	All
Access to Electricity						
No	35.0	39.3	37.3	33.8	34.4	34.1
Yes	65.0	60.7	62.7	23.4	25.4	24.5
All	100.0	100.0	100.0	27.0	28.9	28.1
Average Duration of Availability in a Day						
0-6 hours	43.4	48.9	46.2	32.3	32.1	32.2
7-12 hours	16.4	18.5	17.5	23.6	22.9	23.2
13-18 hours	14.5	17.5	16.1	25.3	29.9	28.0
19-24 hours	25.9	15.3	20.1	21.3	25.1	22.9
All	100.0	100.0	100.0	27.0	28.9	28.1

***Choice of cooking fuel and indoor air-pollution*:** Use of fuels like firewood, crop residue or dung etc. exposes women to harmful smoke while cooking, leading to a higher incidence of respiratory illness among adults and more so for the children (Parikh, et. al., 1999 and Duflo et. al, 2008). This in turn would affect BMI and hence is included in the regression model. Here, cooking fuels like firewood, dung, crop residue, charcoal etc. are referred to as dirty fuels while kerosene and LPG are referred as clean fuel[14]. The use of dirty cooking fuels affects respiratory health mainly if the ventilation in the indoor cooking area is very poor. The data provides such additional information on whether the household cooks mostly indoors and if so whether the kitchen/cooking area has adequate ventilation. All this qualitative information was combined to form the following four categories; the first three are for households that use dirty fuel and the fourth is one that use clean fuel irrespective of kitchen area/type: (i) most indoor pollution-cooking area has no proper ventilation, (ii) lesser indoor pollution-cooking area has some ventilation, (ii) outdoor cooking, and (iv) clean fuel.

Table 16a below shows that more than 90 percent of the women report use of dirty fuels and this can be expected among rural households where crop residue, firewood and cow dung are available in the farm or in the near vicinity. If the usage of dirty fuel is further classified based on the ventilation in the kitchen then we observe that less than 25 percent of the women report that the kitchen/ cooking area is not adequately ventilated. It is clear that the CED rates among such women are the highest, with marginally lower values among those with better ventilation. The CED rate is expectedly lowest among the users of clean cooking fuel. However, one observes that women in farm households have a substantially higher CED rate than the non-farm households even in this category. One possibility is that the women may be using other cooking fuels like crop residue or dung along with cleaner fuels due to the easy availability of these among farm households thereby affecting their BMI. This is in addition to the fact that women in farm households may be more involved in farming activities which anyway puts a physical stress and lowers their BMI.

[14]This classification of fuels is based on Kumar and Viswanathan (2009).

Table 16a: Distribution of Women and CED Rates across Cooking Fuel Used and Kitchen Type

Type of Cooking Fuel Used and Kitchen Type	Distribution of Women (percent)			CED Rates (percent)		
	Non-Farm Hhld	Farm Hhld	All	Non-Farm Hhld	Farm Hhld	All
Fuel Type						
Dirty	89.4	92.1	91.0	28.5	29.3	28.9
Clean	10.6	7.9	9.1	14.6	25.2	19.5
All	100.0	100.0	100.0	27.0	28.9	28.1
Fuel Type and Type of Kitchen Leading to Possibility of Higher/Lower Indoor Pollution						
Use dirty fuel and cooking area has no proper ventilation	21.3	23.3	22.4	31.5	30.5	31.0
Use dirty fuel and cooking area has some ventilation	34.1	39.7	37.1	25.3	28.0	26.9
Outdoor cooking with dirty fuel	34.1	29.3	31.5	29.9	29.9	29.9
Clean fuel	10.6	7.9	9.1	14.6	25.2	19.5
All	100.0	100.0	100.0	27.0	28.9	28.1

Note: Dirty fuel includes firewood, dung, crop residue, charcoal etc. and clean fuels include kerosene and LPG.

Results in Table 16b shows that for those cooking with dirty fuel in outdoors has a marginally lower CED rate compared to those who have poor kitchen ventilation. The tests of hypotheses in the lower part of this table indicates that except for those who use dirty fuel without proper ventilation and those who cook with dirty fuel in the outdoor, the mean CED rates and mean BMI are statistically different. Further, irrespective of the kitchen facility, clean fuel unambiguously is far better off in lowering the CED rates and improving mean BMI.

Table 16b: Comparison of CED Rates and BMI for Women in Households Using Different Fuel Types

	CED (percent)		BMI (kg/m^2)	
Cooking Fuel type and kitchen facility	Coeffs	p-value	Coeffs	p-value
Use dirty fuel and cooking area has no proper ventilation(β_0)	31.0^{***}	0.000	20.2^{***}	0.000
Use dirty fuel and cooking area has some ventilation(β_1)	26.9^{***}	0.000	20.7^{***}	0.000
Outdoor cooking with dirty fuel (β_2)	29.9^{***}	0.000	20.2^{***}	0.000
Clean fuel (β_3)	19.5^{***}	0.000	21.9^{***}	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	22.92^{***}	0.000	58.5^{***}	0.000
H_0: $\beta_0=\beta_2$, H_1: $\beta_0\neq\beta_2$	1.48	0.2241	0.71	0.3993
H_0: $\beta_0=\beta_3$, H_1: $\beta_0\neq\beta_3$	81.3^{***}	0.000	361.0^{***}	0.000
H_0: $\beta_1=\beta_2$, H_1: $\beta_1\neq\beta_2$	15.24^{***}	0.000	56.17^{***}	0.000
H_0: $\beta_1=\beta_3$, H_1: $\beta_1\neq\beta_3$	37.44^{***}	0.000	214.95^{***}	0.000
H_0: $\beta_2=\beta_3$, H_1: $\beta_2\neq\beta_3$	72.73^{***}	0.000	370.09^{***}	0.000

Individual Variables

Age, education, type of employment including those not involved in labour market, short-term morbidity status, pregnancy status, access/use of health care facilities during short-term illness and antenatal care during pregnancy are the individual variables considered for the analysis. Though the database had information on other long-term morbidity like diabetes, hypertension and respiratory illnesses, these had lot of missing observations for women in rural areas.

Age: Since BMI captures change of nutritional status in short run, age can have a negative or a positive impact on BMI of women. It shows the change of BMI with time. It can have negative impact on BMI since younger generations are supposed to be enjoying the benefits of economic and infrastructural changes over time. It can also turn out to be positive showing that older women tend to improve their BMI. Younger women would tend to have lower BMI as reproductive and child caring phases would have an adverse impact on their body weight alongside other household chores. One can also expect the coefficient to be insignificant if other explanatory variables capturing these aspects are factored into the model adequately.

Education Level: This is a categorical variable for the women represented by five groups (i) not literate, or have completed (ii) primary, or (iii) secondary, or (iv) higher secondary or (v) college level education. The reference category in the model is chosen as 'not literate' and the mean BMI is expected to improve with education (controlling for other factors) since an educated woman is more likely to be conscious and aware about her health and well-being. She is more likely to have a diversified diet to get better nutrition and would not support frequent pregnancies. About 50 percent or more women are not literate in both farm and non-farm household (Table 17). The graduates form a very small proportion of the women but the gap in CED rates with the non-literates is almost three times lower.

Table 17: Distribution of Women, CED Rates, Mean and Standard Deviation of BMI (kg/m^2) Across Education Levels of Women

Completed Education Levels	Distribution of women		CED Rates		Mean BMI		Standard Deviation of BMI	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Illiterate	59.5	54.3	31.5	32.3	20.2	20.0	3.09	2.95
Primary+Middle	20.8	23.9	21.7	25.7	21.5	20.8	3.59	3.22
Secondary	12.1	12.8	17.8	24.4	21.6	21.0	3.41	3.42
Higher Secondary	6.2	7.4	22.2	26.3	21.3	20.6	3.31	3.45
Graduate	1.4	1.5	17.5	11.8	21.6	22.2	3.21	3.77

Women's Employment/Occupation Status: There are five dummies referring to the occupation of women:

(i) Self-employed in agriculture comprising of farm work & animal rearing
(ii) Self-employed in agriculture and sometimes engaged as agricultural wage labor
(iii) Only as agricultural wage labor
(iv) Non-agricultural wage labor
(v) Salaried work or in business
(vi) Not actively engaged in any economic activity in the labour market.

The reference category chosen in the econometric model is the last one consisting of women who do not actively participate in the labour market and are involved in domestic work. The sign of the coefficients of the categorical variables may be ambiguous and cannot be predicted *a priori*. It can however be expected that women who are involved in household chores alone are likely to have lesser physical activity when compared to those who are involved in agricultural or non-agricultural wage labour work. Women working as agricultural laborers or as self-employed in agriculture spend a lot of energy in doing the hard manual work on the farm. The self-employed are more likely to be unpaid and wage laborers would receive low wages which are primarily spent on the subsistence consumption of the household, thereby showing no impact of the income effect on BMI. Given this, we expect women in categories (ii) and (iii) above to have the least BMI followed by that in (i). Working women are expected to be better empowered and having access to cash income would find better quality diet more affordable which would be the case predominantly for women in category (v). Further women involved in such work would also have far lower physical activity. So, compared to the reference category we expect either the coefficient for this group to be statistically insignificant and more so in quantile regression model for the lower quantiles.

More women in the labour market among farm households (76.3 percent) than there are among non-farm households (55 percent) indicating the higher participation of women in the agricultural sector (Table 18a). However, 17.4 percent are self-employed in agriculture and20 percent are agricultural wage workers in non-farm households and in farm household about 16 percent work both as farm labour and agricultural wage labour. The CED rates are high among the group involved in wage work.

Table 18a: Distribution of Women, CED Rates, Mean and Standard Deviation of BMI (kg/m^2) across Work Status for Non-farm and Farm Households

Work Status	Distribution of women		CED Rates		Mean BMI		Standard Deviation of BMI	
	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld	Non-Farm	Farm Hhld
Self-employed in agriculture	17.4	57.3	32.5	28.6	20.4	20.5	3.37	3.18
Self-employed in agriculture and agricultural wage labor	6.5	15.5	34.2	38.1	19.7	19.5	2.58	2.71
Agricultural wage labor	20.5	1.8	31.9	36.9	20.2	19.4	3.03	2.59
Non-agricultural wage labour	4.4	0.5	26.9	47.7	20.3	19.1	2.80	2.67
Other Work	6.3	1.1	25.4	30.3	21.2	20.7	3.77	3.62
Not in the labour market	44.9	23.7	21.9	22.7	21.2	20.9	3.40	3.29
All	100.0	100.0	27.0	28.9	20.7	20.4	3.31	3.17

Note: Work status refers to the type of work carried out by the women in the labour market; Other Work includes Salaried and Business.

In Table 18b, we observe that women self-employed in agriculture (β_0) have lower CED rates and higher mean BMI compared to those self-employed and working as agricultural labour (β_1) or engaged in agricultural labour (β_2) but same for non-agricultural labour (β_3). Observing the results from the paired tests of hypotheses in the lower panel of Table 18b shows that there is no difference in CED rates or mean BMI between agricultural labour and non-agricultural labour while the mean BMI of those who do other non-agricultural work (salaried, business etc.) are not different from those not engaged in the labour market. Also the CED rates between self-employed in agriculture is no different from agricultural wage labour and this result may be driven by the fact that among the non-farm households the women who report non-agricultural wage labour have substantially low CED rates than all other wages labour categories.

Table 18b: Comparison of CED Rates and BMI AcrossNature of Employment

Nature of Employment	**CED (percent)**		**BMI (kg/m^2)**	
	Coefficients	p-value	Coefficients	p-value
Self-employed in agriculture (β_0)	29.5***	0.000	20.4***	0.000
Self-employed in agriculture and agricultural wage labor(β_1)	37.1***	0.000	19.6***	0.000
Agricultural wage labor (β_2)	32.4***	0.000	20.1***	0.000
Non-agricultural wage labour (β_3)	29.4***	0.000	20.1***	0.000
Other Work (β_4)	26.2***	0.000	21.1***	0.000
Not participating in the labour market (β_5)	22.2***	0.000	21.1***	0.000
Tests of hypothesis	F-statistic	p-value	F-statistic	p-value
H_0: $\beta_0=\beta_1$, H_1: $\beta_0\neq\beta_1$	48.51***	0.000	125.27***	0.000
H_0: $\beta_0=\beta_2$, H_1: $\beta_0\neq\beta_2$	6.48**	0.011	15.72***	0.000
H_0: $\beta_0=\beta_3$, H_1: $\beta_0\neq\beta_3$	0.00	0.982	3.60*	0.057
H_0: $\beta_0=\beta_4$, H_1: $\beta_0\neq\beta_4$	3.35*	0.067	28.57***	0.000
H_0: $\beta_0=\beta_5$, H_1: $\beta_0\neq\beta_5$	91.86***	0.000	146.48***	0.000
H_0: $\beta_1=\beta_2$, H_1: $\beta_1\neq\beta_2$	11.54***	0.001	30.91***	0.000
H_0: $\beta_1=\beta_3$, H_1: $\beta_1\neq\beta_3$	10.63***	0.001	11.72***	0.000
H_0: $\beta_2=\beta_3$, H_1: $\beta_2\neq\beta_3$	1.53	0.216	0.02	0.897
H_0: $\beta_4=\beta_5$, H_1: $\beta_4\neq\beta_5$	4.85**	0.028	0.05	0.816

Short term morbidity status and access to type of medical care: We use short term morbidity status captured by the number of days ill with fever etc. a month prior to the survey so that we expect that this could have resulted in loss of body weight and hence a lower average BMI even after controlling for other variables. Further, this variable is interacted with the type of medical care facility used if at all used, when reported sick. The medical care sought is classified as: (i) ill but did not seek treatment; (ii) ill and visits public doctor; (iii) ill and visits private doctor; (iv) ill and seeks traditional help. Table 19 shows that about 10 percent of the women report short term morbidity. More proportion of women sought advice from a private doctor and the CED rate among them is fairly high. Those who report visiting a traditional doctor have the highest CED rates but their share is very low.

Table 19: Distribution of Women, CED Rates, Mean and Standard Deviation of BMI (kg/m^2) across Short-term Morbidity Status and Type of Health Care Services Accessed

Short-term Morbidity Status and Health Care Type Accessed	Distribution of women		CED Rates		Mean BMI		Standard Deviation of BMI	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Not ill	89.8	89.5	26.2	28.2	20.8	20.4	3.31	3.15
Ill but did not seek treatment	0.9	0.9	43.6	25.9	20.1	20.3	3.51	2.93
Ill and visits public doctor	2.3	2.1	26.8	31.2	20.7	20.2	3.34	3.44
Ill and visits private doctor	6.9	7.3	36.2	37.1	20.1	19.8	3.25	3.27
Ill and seeks traditional help	0.3	0.3	19.7	41.6	21.0	18.9	3.77	2.69
All	100.0	100.0	27.0	28.9	20.7	20.4	3.31	3.17

Pregnancy status and access to antenatal care: A pregnant woman should on an average have a higher BMI compared to others and hence has been used as control variable.Though one could have dropped the group of women who are pregnant but the intention is also to assess how access to antenatal care among such women impacts their BMI after controlling for other variables. So the focus is more on the possible effect of access to health care and its impact on BMI and how the magnitude of this coefficient varies in the quintile regression model. To capture the variations in access to different sources of health care, the women who report pregnant have been classified into: (i) pregnant but no access to antenatal care; (ii) pregnant with access to antenatal care and visiting doctor or nurse; (iii) pregnant with access to antenatal care and visiting *dai* or others. About 4-5 percent of the women in the age-group of 20-45 years have reported as pregnant during the year of the survey (Table 20). The mean BMI of these women is higher by about one unit for some of the categories and the CED rates are lower. However, we observe that women who do not seek antenatal care have far lower CED rates.

Table 20: Distribution of Women, CED Rates, Mean and Standard Deviation of BMI (kg/m^2) across Pregnancy Status and Type of Antenatal Care Services Accessed

Pregnancy Status and Antenatal Care Type Accessed	Distribution of women		CED Rates		Mean BMI		Standard Deviation of BMI	
	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld	Non-Farm Hhld	Farm Hhld
Not Pregnant	96.5	95.2	27.5	29.6	20.7	20.4	3.34	3.19
Pregnant and no access to antenatal care	1.1	1.7	40.8	12.5	20.0	21.4	3.30	2.75
Pregnant and visiting a doctor or nurse	2.3	2.6	18.9	23.9	21.0	20.5	2.97	2.86
Pregnant and visiting *dai*or others	0.2	0.3	4.3	6.9	21.3	21.4	2.22	2.38
All	100.0	100.0	27.4	29.1	20.7	20.4	3.33	3.17

State level variations

State level policies or the quality of service delivery of the central (welfare) schemes as well as other economic, social and cultural features that could systematically differ across states of India can have differential impacts on the average BMI across states. In order to account for this, dummy variables for each of the state with Punjab as the reference state is included in the analysis. Punjab is chosen as the reference state as among all the states it has the highest mean value of total land area cultivated, has a very large share of households engaged in agriculture in rural areas and also has one of the low rates of CED among women. Table 21 below shows that a larger share of women are from states like Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, West Bengal, Orissa and Maharashtra. Noteworthy is that in many states, CED rates are lower among women in farm households than in non-farm household except for states like Rajasthan, Orissa, Gujarat, Maharashtra.

Table 21: Distribution of Women and CED rates across States of India (in percent)

States	Distribution		CED Rates		States	Distribution		CED Rates	
	NF-H	F-H	NF-H	F-H		NF-H	F-H	NF-H	F-H
Jammu & Kashmir	0.5	1.6	17.1	13.3	Madhya Pradesh	4.0	5.7	30.3	28.9
Himachal Pradesh	0.2	1.2	22.9	20.6	Northeast states	1.4	0.7	8.0	7.7
Uttarakhand	1.1	2.4	45.1	37.4	Assam	3.6	2.5	2.5	2.3
Punjab	3.1	1.2	10.3	8.3	West Bengal	10.2	7.3	33.8	28.8
Haryana	2.6	1.5	16.7	15.7	Orissa	3.3	6.0	33.7	38.2
Delhi	0.1	0.0	2.0	0.0	Gujarat	4.1	4.4	31.8	34.5
Uttar Pradesh	9.4	17.4	36.2	32.1	Maharashtra, Goa	7.1	11.2	31.4	36.9
Bihar	7.3	8.6	29.2	25.9	Andhra Pradesh	15.0	4.4	27.2	24.4
Jharkhand	3.9	4.7	31.5	24.5	Karnataka	4.3	4.5	36.8	35.6
Rajasthan	3.1	6.4	18.9	25.6	Kerala	4.3	1.7	8.1	8.4
Chhattisgarh	1.5	4.4	37.7	35.2	Tamil Nadu	9.8	2.3	22.6	23.4

Note: NF-H: Non-farm household, F-H: Farm household.

Chapter 8

EMPIRICAL EVIDENCE: ECONOMETRIC ESTIMATIONS

Probit model for CED: Farm versus non-farm households

This section first presents the results for probit model with the dependent variable representing binary variable of whether the woman is CED (BMI less than 18.5) or not. This analysis is presented mainly to compare the farm and non-farm households and and also for following variants of the model which differ in how agriculture/non-agriculture related aspects feature in the model: (i) Variant 1 has household's major source of income as categorical variables, (ii) Variant 2 has share of income from various economic activities and (iii) Variant 3 has a binary variable for land cultivation (or not) along with share of income from agriculture and allied activities.

The results in Table 22 show that in all variants, the likelihood of CED is less likely among households that depend primarily on cultivation or agriculture in general in rural areas after controlling for economic status. Results from variant 1 shows that women in cultivator or agricultural wage labour households have lower CED; variant 2 shows that share of income from livestock rearing reduces the likelihood of CED substantially and so do other agricultural activities; variant 3 shows that with larger share of net agricultural incomes, the likelihood of CED is lower while a higher share of non-agricultural wage income increases the likelihood. Further, dietary diversity variable in the form of either DDI (variant 1) or expenditure share of cereals in total food expenditure (variants 2 and 3) is significant at 1 percent. The coefficient of DDI is negative and that of cereal expenditure share is positive so that higher dietary diversity reduces the likelihood of CED. Other control variables pertaining to economic status, household amenities, and individual characteristics of these women are by and large significant at 1 percent or 5 percent. These other estimates show that women from higher asset quintile households, with lesser restrictions in terms of mobility or purdah practice, non-Hindus or non-Muslims, non-SC/ST, larger households with lower proportion of children, and households with some form of water purification, some form of toilet usage are all less likely to be CED. As for the individual characteristics, older women, women who are not self-employed in agriculture, those have access to better antenatal care among pregnant women are also less likely to be CED. The model also includes state dummy variables, which is reported in Appendix Table A.1. A state like Assam has a far lower CED than Punjab while most other states have the coefficient positive and significant at 1 percent level of significance (except Tamil Nadu at 10 percent level of significance) indicating that there are still differences across states that could not be captured using these set of explanatory variables.

Table 22: Estimates from Probit Model For CED Comparing Agricultural Household With Non-Agricultural In Rural India

Variables	Variant 1		Variant 2		Variant 3	
	Coeffcient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Household's Major Source of Income [Other sources=reference]						
Agriculture and allied Activities	-0.197**	0.027				
Agricultural labour	-0.237**	0.011				
Non-agricultural labour	-0.004	0.964				
Artisans	-0.174	0.119				
Petty trade and business	-0.180*	0.071				
Salaried and professionals	-0.144	0.133				
Household Income Diversity [other income shares except from agriculture and non-agricultural wage=reference]						
Share of income from cultivation			-0.143**	0.016		
Share of income from livestock rearing			-0.254**	0.015		
Share of agricultural property income			-0.175	0.254		
Share of agricultural wage income			-0.114*	0.079		
Share of non-agricultural wage income			0.13*	0.063	0.127*	0.070
Share of total agricultural income					-0.146***	0.003
Cultivates land					0.059	0.265
Income Diversity Index	0.119	0.108				
Dietary Diversity Index	-.557**	0.036				
Expenditure share of cereals in total food expenditure			0.451**	0.016	0.464**	0.013
Logarithm of per capita income	-0.028	0.205	-0.030	0.174	-0.028	0.201
Logarithm of monthly per capita consumption expenditure	0.035	0.318	0.065*	0.067	0.0615*	0.081
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]						
Quintile 2 or 'Poor'	-0.028	0.562	-0.031	0.519	-0.031	0.516
Quintile 3 or 'Middle'	-0.146***	0.006	-0.145***	0.006	-0.147***	0.006
Quintile 4 or 'Rich'	-0.216***	0.002	-0.213***	0.002	-0.217***	0.002

Variables	Variant 1		Variant 2		Variant 3	
	Coeffcient	p-value	Coefficient	p-value	Coefficient	p-value
Quintile 5 or 'Richest'	-.365***	0.000	-0.359***	0.000	-0.361***	0.000
Log of Household Income per person (Rs.)	-0.0275	0.205	-0.0304	0.174	-0.0284	0.201
Log of Total Consumption Expenditure per person (Rs.)	0.0346	0.318	0.065*	0.067	0.0615*	0.081
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]						
Quintile 2 or 'Poor'	-0.0281	0.562	-0.0314	0.519	-0.0318	0.516
Quintile 3 or 'Middle'	-0.146***	0.006	-0.145***	0.006	-0.147***	0.006
Quintile 4 or 'Rich'	-0.216***	0.002	-0.213***	0.002	-0.217***	0.002
Quintile 5 or 'Richest'	-0.365***	0.000	-0.359***	0.000	-0.361***	0.000
Allowed to purchase groceries (Yes=1, No=1)	-0.0859**	0.014	-0.081**	0.018	-0.082**	0.016
Eat with family members (Yes=1, No=0)	-0.0294	0.377	-0.0319	0.339	-0.031	0.356
Do not practice Purdah (Yes=1, No=0)	-0.14***	0.000	-0.135***	0.001	-0.137***	0.001
Religion [Hindus=reference]						
Islam	-0.0421	0.459	-0.0615	0.279	-0.057	0.313
Christianity	-0.278**	0.017	-0.259**	0.026	-0.256**	0.028
Other religions	-0.256***	0.002	-0.255***	0.002	-0.255***	0.002
Caste [Scheduled Tribe =reference]						
Upper Caste Hindus	-0.283***	0.003	-0.286***	0.003	-0.284***	0.003
Other Backward Classes	-0.176***	0.002	-0.179***	0.001	-0.181***	0.001
Scheduled Caste	-0.0433	0.470	-0.0651	0.269	-0.062	0.295
Other castes	-0.15**	0.015	-0.142**	0.021	-0.144**	0.019
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]						
Share of members in age group 4-14 years	-0.211	0.102	-0.223*	0.085	-0.225*	0.082
Share of members in age group 15-60 years	-0.399***	0.007	-0.419**	0.004	-0.42***	0.004
Share of members above the age of 60 years	-0.577***	0.004	-0.536***	0.007	-0.543***	0.006
Household Size	-0.0153**	0.027	-0.0136**	0.039	-0.0139**	0.034
Drinking water is treated in some form (Yes=1, No=0)	-0.219***	0.000	-0.225***	0.000	-0.226***	0.000
Sanitation Facility [None, open fields= reference]						
Traditional latrine	-0.198***	0.000	-0.201***	0.000	-0.202***	0.000
VIP latrine	-0.197**	0.020	-0.194**	0.021	-0.192**	0.022
Flush toilet	-0.181***	0.001	-0.181***	0.001	-0.182***	0.001
House has access to electricity (Yes=1, No=0)	-0.0165	0.691	-0.022	0.593	-0.0211	0.608

Variables	Variant 1		Variant 2		Variant 3	
	Coeffcient	p-value	Coefficient	p-value	Coefficient	p-value
Use clean cooking Fuel (Yes=1, No=0)	0.0138	0.809	0.00264	0.963	0.0035	0.951
Age	-0.012***	0.000	-.0118***	0.000	-0.012***	0.000
Completed Education level of the woman [Not literate=reference]						
Primary or Middle	-0.0474	0.216	-0.0469	0.219	-0.0485	0.201
Secondary	-0.0178	0.758	-0.0138	0.810	-0.0161	0.778
Higher secondary	0.0288	0.783	0.025	0.810	0.0216	0.834
Graduate and Above	0.00673	0.961	0.0105	0.938	0.0059	0.965
Employment Status [Not in the labour force =1]						
Self-employed in agriculture	0.131***	0.007	0.17***	0.000	0.158***	0.001
Self-employed in agriculture and agricultural labour	0.11*	0.052	0.165***	0.004	0.166***	0.003
Agricultural labour	0.0332	0.572	0.0551	0.372	0.0701	0.226
Non-agricultural labour	-0.014	0.885	-0.056	0.573	-0.0582	0.562
[Not Pregnant=Reference]						
pregnant but no antenatal access	-0.455***	0.004	-0.468***	0.003	-0.466***	0.003
pregnant with antenatal access and going to doctor or nurse	-0.348***	0.001	-0.336***	0.002	-0.341***	0.001
pregnant with antenatal access and going to dai or others	-1.13***	0.001	-1.16***	0.001	-1.16***	0.001
Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]						
ill but did not seek treatment	0.167	0.295	0.159	0.321	0.158	0.327
ill and goes to public doctor	0.0419	0.668	0.0404	0.682	0.0403	0.683
ill and goes to private doctor	0.225***	0.000	0.22***	0.000	0.221***	0.000
ill and seeks traditional help	-0.0351	0.873	0.010	0.964	0.009	0.968
Intercept	0.881**	0.016	-0.007	0.983	-0.021	0.949

Note: *p-value<0.10; ** p-value <0.05; *** p-value <0.01

Estimations for Farm Households

Table 23 presents the descriptive statistics of the variables used in the econometric estimations among farm households. Mean BMI is well above the threshold of 18.5 and dietary diversity index has an average closer to one. Average number of crops grown is less than two with an average share of agricultural income being 66 percent in total household income. About 54 percent of these women are not literate while about 35 percent of them have at least one member whose highest education level is primary or middle school. About 34 percent of these women are allowed to purchase groceries, 30 percent eat with their family members and 34 percent do not follow the practice of *purdah*. About 57 percent of these women are self-employed in agriculture, 16 percent work as agricultural labour and self-employed in agricultural work and 24 percent are not in the labour force. With regard to access to seeking health care when required, a larger per cent seeks help from private care even among farm households.

Table 23: Descriptive Statistics of Variables For Farm Households

Variable	Mean	Standard deviation	Variable	Mean	Standard deviation
BMI	20.4	3.17	Household: Not literate	0.21	0.408
Dietary Diversity Index	0.82	0.085	Household: Primary or Middle	0.35	0.476
Production Diversity Index	0.45	0.273	Household with Secondary	0.22	0.414
Log of total land area cultivated (acres)	3.24	1.118	Household with Higher secondary	0.12	0.319
Log of total Agricultural Income (Rs.)	9.56	1.190	Household with Graduate and Above	0.11	0.311
Share of Sale of Own Produce	0.35	0.366	Allowed to purchase groceries	0.34	0.473
Number of Crops Grown	2.8	1.698	Eat with family members	0.40	0.489
Log of Household Income per person (Rs.)	8.42	0.938	Do not practice Purdah	0.34	0.473
Share of total agricultural income	0.66	0.359	Has access to electricity	0.61	0.488
Share of non-agricultural wage income	0.12	0.247	Use clean cooking Fuel	0.08	0.269
Share of members in age group 4-14 years	0.24	0.193	Use clean cooking Fuel	0.13	0.333
Share of members in age group 15-60 years	0.60	0.204	Open defecation	0.75	0.433
Share of members above the age of 60 years	0.06	0.098	Traditional latrine	0.10	0.300
Household Size	6.5	3.028	VIP latrine	0.04	0.203
Age	32.2	7.297	Flush toilet	0.11	0.308
Ownership of draft animals	0.53	0.499	Not literate	0.54	0.498
Ownership of cows and buffaloes	0.59	0.491	Primary or Middle	0.31	0.462
Ownership of small ruminants	0.34	0.474	Secondary	0.10	0.306
Ownership of poultry and others	0.56	0.496	Higher secondary	0.03	0.180
Asset Quintile 1 or 'Poorest'	0.15	0.362	Graduate and Above	0.02	0.122
Asset Quintile 2 or 'Poor'	0.22	0.414	Self-employed in agriculture	0.57	0.495
Asset Quintile 3 or 'Middle'	0.21	0.404	Self-employed in agriculture and agricultural labour	0.16	0.363

Variable	Mean	Standard deviation	Variable	Mean	Standard deviation
Asset Quintile 4 or 'Rich'	0.20	0.400	Agricultural labour	0.02	0.134
Asset Quintile 5 or 'Richest'	0.22	0.414	Non-agricultural labour	0.01	0.071
			Not in labour force	0.24	0.425
Hindus	0.86	0.346	Not Pregnant	0.95	0.209
Islam	0.09	0.287	pregnant but no antenatal access	0.02	0.126
Christianity	0.01	0.113	pregnant with antenatal access and going to doctor or nurse	0.03	0.159
Others	0.04	0.186	pregnant with antenatal access and going to *dai* or others	0.00	0.059
Upper Caste Hindus	0.05	0.217	No illness (short-term morbidity) reported in the last 30 days	0.89	0.308
Other Backward Classes	0.44	0.497	ill but did not seek treatment	0.009	0.094
Scheduled Caste	0.17	0.377	ill and goes to public doctor	0.021	0.143
Scheduled Tribes	0.10	0.306	ill and goes to private doctor	0.073	0.261
Other Castes	0.23	0.423	ill and seeks traditional help	0.003	0.057

Probit model for CED: Relevance of Production and Livestock diversity among Farming Households

The probit model for CED is estimated for women only from farm households (those who cultivate at least one crop) and the results in Table 24 now includes more variables pertaining to farming. The variables included in this analysis are area under cultivation, production diversity as a diversity index based on area share, net farm income, diversity in livestock which as explained in Chapters 6 and 7. In variant 1 of the model PDI, total area under cultivation and the number of animals in each of the livestock categories are included. In variant 2 the livestock categories are treated as dummy variables (having or not having an animal in that category) and variant 3 considers an additional variable- net agricultural income of the household.

The results show that PDI variable (based on area share, is not significant) in any of these variants. Total area under cultivation is significant only when net agricultural income is excluded but the latter is also not significant in variant 3. However, in Variants 1 and 2, larger area under cultivation reduces the likelihood of CED after controlling for other variables. Women in households with small ruminants are more likely to be CED and all other categories of livestock have similar effect on CED. Once the asset status of the household is controlled for, per capita household income, per capita consumption expenditure, income diversity or dietary diversity are all insignificant. Women's better status reduces the likelihood of CED and most other results are similar to that for all rural households as shown in Table 22. The state level dummy coefficients are reported in Appendix Table A.2 which show substantial variation in the magnitude of the coefficient.

Table 24: Estimates from Probit Model For CED Among Farm Household

	Variant 1		**Variant 2**		**Variant 3**	
Variable	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**
Production Diversity Index	0.058	0.521	0.055	0.551	0.062	0.507
Logarithm of total area cultivated in acres	-0.057**	0.025	-0.044*	0.079	-0.032	0.248
Number of cows and buffaloes	0.000	0.987				
Number of goats and sheep	0.011*	0.057				
Number of poultry animals	0.000	0.982				
Number of draft animals	0.015	0.442				
Possess cows and buffaloes (Yes/no)			-0.019	0.686	-0.019	0.695
Possess goats and sheep			0.078*	0.087	0.081*	0.083
Possess poultry animals			0.003	0.941	0.025	0.577
Logarithm of net farm income					-0.033	0.165
Log of Household Income per person (Rs.)	0.007	0.801	0.010	0.716	0.043	0.168
Log of Total Consumption Expenditure per person (Rs.)	0.029	0.532	0.031	0.503	0.020	0.671
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]						
Quintile 2 or 'Poor'	-0.047	0.456	-0.019	0.770	-0.027	0.677
Quintile 3 or 'Middle'	-0.19***	0.007	-0.155**	0.029	-0.171**	0.018
Quintile 4 or 'Rich'	-0.31***	0.000	-0.261***	0.002	-0.26***	0.002
Quintile 5 or 'Richest'	-0.4***	0.000	-0.35***	0.000	-0.34***	0.000
Income diversity Index	0.109	0.241	0.115	0.219	0.178*	0.066
Dietary Diversity Index	-0.357	0.225	-0.327	0.265	-0.336	0.256
Women's Status Variables						
Allowed to purchase groceries (Yes=1, No=1)			0.005	0.912	0.000	0.999
Eat with family members (Yes=1, No=0)			-0.087**	0.048	-0.096**	0.031
Do not practice Purdah (Yes=1, No=0)			-0.19***	0.000	-0.20***	0.000
Religion [Hindus=reference]						
Islam	-0.009	0.908	-0.060	0.456	-0.099	0.233
Christianity	-0.86***	0.001	-0.80***	0.001	-0.76***	0.003
Other religions	-0.239*	0.060	-0.21*	0.097	-0.187	0.143
Caste [Scheduled Tribe =reference]						

	Variant 1		Variant 2		Variant 3	
Variable	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**
Upper Caste Hindus	-0.333***	0.006	-0.342***	0.005	-0.3**	0.014
Other Backward Classes	-0.142*	0.057	-0.154**	0.041	-0.126*	0.097
Scheduled Caste	-0.070	0.405	-0.098	0.242	-0.075	0.373
Other castes	-0.166**	0.044	-0.169**	0.042	-0.121	0.150
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]						
Share of members in age group 4-14 years	0.075	0.685	0.055	0.765	-0.031	0.870
Share of members in age group 15-60 years	-0.332*	0.090	-0.292	0.135	-0.338$^{\#}$	0.088
Share of members above the age of 60 years	-0.203	0.435	-0.159	0.545	-0.145	0.584
Household Size	-0.022**	0.011	-0.018*	0.031	-0.015$^{\#}$	0.081
Drinking water is treated in some form (Yes=1, No=0)	-0.24***	0.000	-0.24***	0.000	-0.24***	0.000
Sanitation Facility [None, open fields= reference]						
Traditional latrine	-0.186**	0.016	-0.151*	0.053	-0.16**	0.038
VIP latrine	-0.279**	0.014	-0.252**	0.028	-0.34***	0.004
Flush toilet	-0.238***	0.003	-0.22***	0.005	-0.22***	0.005
Average Durations of Electricity Available in a Day [0-6 hours=Reference]						
7-12 hours	-0.031	0.610				
13-18 hours	-0.006	0.925				
19-24 hours	0.014	0.844				
Cooking Fuel and Kitchen Type [Use of dirty fuel with no proper ventilation in cooking area=Reference]						
Use dirty fuel and cooking area has some ventilation	0.053	0.332				
Outdoor cooking with dirty fuel	-0.030	0.590				
Clean Cooking Fuel	0.167*	0.060				
House has access to electricity (Yes=1, No=0)			-0.053	0.332	-0.070	0.202
Use clean cooking Fuel (Yes=1, No=0)			0.150*	0.057	0.148*	0.065
Age	-0.009***	0.003	-0.009***	0.003	-0.008***	0.008
Completed Education level of the woman [Not literate=reference]						
Primary or Middle	-0.080	0.134	-0.038	0.442	-0.040	0.433
Secondary	-0.038	0.650	0.014	0.859	-0.008	0.918
Higher secondary	-0.189	0.144	-0.117	0.333	-0.145	0.238
Graduate and Above	-0.35*	0.045	-0.220	0.169	-0.205	0.200
Employment Status [Not in the labour force =Reference]						
Self-employed in agriculture	0.078	0.158	0.080	0.155	0.076	0.187
Self-employed in agriculture and agricultural labour	0.080	0.291	0.083	0.278	0.105	0.177
Agricultural labour	0.001	0.992	0.001	0.996	0.026	0.848
Non-agricultural labour	0.474*	0.054	0.432*	0.073	0.525**	0.040

	Variant 1		Variant 2		Variant 3	
Variable	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**
Pregnancy and Antenatal Care Access [Not Pregnant=Reference]						
pregnant but no antenatal access	-0.83***	0.000	-0.81***	0.000	-0.81***	0.000
pregnant with antenatal access and going to doctor or nurse	-0.260*	0.054	-0.247*	0.071	-0.26*	0.064
pregnant with antenatal access and going to *dai* or others	-1.03***	0.009	-1.01**	0.014	-1.01**	0.015
Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]						
ill but did not seek treatment	-0.203	0.254	-0.216	0.231	-0.236	0.197
ill and goes to public doctor	0.097	0.464	0.088	0.507	0.057	0.663
ill and goes to private doctor	0.216***	0.003	0.213***	0.003	0.233***	0.001
ill and seeks traditional help	0.266	0.357	0.214	0.426	0.208	0.435
Intercept	0.0237	0.959	0.1730	0.687	0.2176	0.621
Sample Size	9882		9882		9882	

Note: *p-value<0.10; ** p-value <0.05; *** p-value <0.01.

Estimates from Instrumental Variable Quantile Regression Model

Given that the probit estimates above do not indicate significant impacts of most of the agriculture variables in the Table above, we also estimate OLS and quantile regression models for variables in variant 1 of Table 24. The results reported in Table A.3 (in Appendix A) show that once again many of the household level variables like dietary diversity and agricultural variables relevant from the perspective of this study are not statistically significant. Hence we propose a reformulation of the econometric specification.

We expect dietary diversity to be endogenous and use BMI as a continuous variable rather than as categorical variable (presence or absence of CED). We estimate an instrumental variable quantile regression model and hope to see differences in impacts of the regressors across BMI quintiles. Such a framework also enables us to model the two different aspects of nutritional security simultaneously. First equation for dietary diversity captures how features of access, affordability and awareness explain the variations at the farm household level. The second equation for BMI captures some of these features as well as environmental factors and health (care) variables. Thus, it captures nutritional intake at the household level and nutritional outcome at the individual level. This two-stage model is estimated with the first stage explaining the variations in dietary diversity and the second stage is a quantile regression model with BMI as the explained variable and household dietary diversity variable as estimated from the first equation, is one of the explanatory variables. Most of the regressors used in the first stage are household level variables while those in the second stage are individual and household characteristics that would directly impact women’s BMI.

Estimates in Table 25 for the dietary diversity equation show that agricultural variables matter significantly. The production diversity index (for area shares) and total area under cultivation are positively significant at 10 percent and 1 percent levels of significance respectively. The net agricultural income however, is negatively significant and this could be because productivity per acre declines as shown earlier in Table 5; so that after controlling for area under cultivation this coefficient is negative[15]. Unlike for the CED equations where small ruminants had an impact, here we observe that the presence of cows and buffaloes in the home has a positive and significant impact on dietary diversity. This finding is similar to Bhagowalia*et al* (2012a) who found that cow/buffalo ownership was a strong predictor of milk consumption among these households. Alongside this result we also observe that the value-share of crops sold in the market has a positive influence on dietary diversity. Thus we observe that both home-production and cash income from the sale of crop produce in the market improves access to diversified diet perhaps both in quantity and quality.

All the economic status variables are positive and significant with the expected signs. Despite these results one observes that among farm households dietary diversity is lower among households with higher share of agricultural income or non-agricultural wage income compared to a household which has other income sources. Muslim households have a higher dietary diversification compared to Hindu households and the different castes have a higher dietary diversity than the ST household. Similarly if the education level of highest educated adult in the household is high then it significantly influences dietary diversity. Larger households as well as those with higher share of adults have less diversified diet.

[15]One would expect area under cultivation and agricultural income to be positively correlated but the correlation between the two was not very high to result in multicollinearity (leading to a change in sign when used along with area under cultivation). This result is most likely driven by the fact that net agricultural productivity is higher for small farms as has been observed in Gaurav and Mishra (2011) and an early empirical finding by Sen (1964).

Table 25: Estimates from the Dietary Diversity Equation (First stage)

Variables	**Coefficient**	**p-values**
Production diversity index	0.007*	0.072
Log of total land area cultivated (acres)	0.0039***	0.000
Log of total Agricultural Income (Rs.)	-0.004**	0.014
Share of Sale of Own Produce	0.0056**	0.037
Ownership of livestock [draft animals is the reference category]		
cows/buffaloes (Yes=1, No=0)	0.007***	0.000
Small ruminants (Yes=1, No=0)	-0.002	0.438
Poultry and others (Yes=1, No=0)	0.001	0.542
Log of Household Income per person (Rs.)	0.00526***	0.009
Log of Total Consumption Expenditure per person (Rs.)	0.0148***	0.000
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]		
Quintile 2 or 'Poor'	0.0144***	0.000
Quintile 3 or 'Middle'	0.0221***	0.000
Quintile 4 or 'Rich'	0.0286***	0.000
Quintile 5 or 'Richest'	0.0281***	0.000
Share of Agricultural Income in Total Income	-0.0123**	0.021
Share of Non-agricultural Wage Income	-0.0158***	0.000
Religion of the household head [Hindus=reference]		
Islam	0.00925***	0.001
Christianity	-0.004	0.590
Others	-0.02*	0.057
Caste of the household head [Scheduled Tribe =reference]		
Upper Caste Hindus	0.0279***	0.000
Other Backward Classes	0.0185***	0.000
Scheduled Caste	0.0154***	0.000
Other	0.0212***	0.000
Education of the household head [Not literate=reference]		
Primary or Middle	0.004	0.129
Secondary	0.0075***	0.005
Higher secondary	0.0088***	0.001
Graduate and Above	0.0079**	0.022
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]		
Share of members in age group 4-14 years	-0.011*	0.089
Share of members in age group 15-60 years	-0.0156**	0.029
Share of members above the age of 60 years	-0.012	0.224
Household Size	-0.0009**	0.021
Intercept	0.684***	0.000

Note: *p-value< 0.10; **p-value<0.05; *** p-value <0.01.

The estimates from the quantile regression model in Table 26a shows that dietary diversity does not influence households significantly for the bottom quantile andfor the others the magnitude increases with the quantile after controlling for other factors. It is observed that only a few variables are significant for the bottom quintile while state dummy variables are significantly different for most states compared to the based state of Punjab. A larger number of variables are significant closer to the middle of the distribution - for the 0.4 and 0.6 quantiles. This is more so in the case of caste perhaps due to the fact that there is more variability in caste groups in the middle than at the lower or upper end of the BMI distribution. BMI of women in the upper quintiles is more affected by socio-cultural practices say, of men eating ahead of women or the purdah practice. Hindu women seem to be disadvantaged for most of the quantiles. Stronger positive impact is also noted due to purification of drinking water or better sanitation facilities.

Among individual variables, education did not matter so much for BMI and instead the nature of employment carried out by the women matters significantly[16]. The BMI of women in agricultural employment whether in the farm or as wage labour as well as those in non-agricultural wage employment are worse off and the impact is more visible in the upper quantiles. It is usually observed that more women from economically weaker sections and in rural areas participate in the labour market. The fact the employment status turns out to be significant after controlling for economic status of the household suggests that this may be due to differences in physical activity of those who are engaged more in manual work compared to women in other types of employment. Once again, the effect is more visible in the upper quantiles as the contrast perhaps becomes more evident for them.

Average BMI for pregnant woman is naturally expected to be higher than others. As mentioned earlier pregnant women were further classified into groups based on what type of antenatal care they were seeking as shown in Table 1 and explained in Chapter 6. As expected the coefficients are positive and significant in most quantiles, although the magnitude of this coefficient is lower for women who are accessing trained practitioners and professionals compared to those who do not seek any care or go to the *dai* or others. This may appear counter-intuitive but is a reflection of care seeking behaviour. Among the pregnant women who are worse off in their BMI are perhaps seeking

[16]In the rural areas the average education level is low the labour market participation is primarily in agricultural activities which does not require higher levels of education. Given this, once types of occupation are controlled for, education turns out to be insignificant.

antenatal care as they perceive themselves to need more attention and care from the professionals.

However, our assessment of this attitude in care seeking behaviour does not seem to apply for those women who report short-term illness and the type of care that they are seeking for the illness. The average BMI after controlling for other explanatory variables is no different for those who are ill but do not seek any medical advice perhaps due to the fact that the illness may not be severe and hence there is no perceptible decline in BMI. Among the other women who report small illness during the past month and who sought medical help the average BMI is lower for those who sought traditional help than those who went to the doctor. This could be could be expected as many women in rural areas may not have access to regular/periodic medical attention so that traditional help sought was more frequent among those who were more ill given that the illness is not that severe. This result is observed for all the quantiles though the gap in decline of BMi is smaller for the middle ones.

The coefficient estimates in the Table 26a show that the magnitude of the coefficients vary across the BMI deciles and hence the BMI equation estimated using the 3SLS method for an average may not be valid. The result for the 3sls model is available for a comparison in Table A.5a for the dietary diversity equation and Table A.5b for BMI equation.

As for the regional variations the dummy coefficients are by and large significant and negative compared to the reference state of Punjab for each of the quintiles (Table 26b). Thus, despite a large number of variables in the regression model there is still unexplained difference across states of India captured by these dummy variables.

Table 26a: Estimates from Quantile Regression (Second Stage)

Quantiles→	0.1		0.2		0.4	
Variables ↓	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**
Log of Total Consumption Expenditure per person (Rs.)	-0.010	0.941	-0.037	0.645	0.141^{***}	0.005
(Predicted value of) Dietary Diversity Index	5.660	0.137	7.62^{***}	0.001	5.51^{***}	0.000
Allowed to purchase groceries (Yes=1, No=1)	0.137	0.147	0.132^{**}	0.026	-0.051	0.201
Eat with family members (Yes=1, No=0)	0.094	0.384	0.113^{*}	0.075	0.161^{***}	0.000
Do not practice Purdah (Yes=1, No=0)	0.114	0.352	0.194^{**}	0.008	0.359^{***}	0.000
Religion [Hindus=reference]						
Islam	0.101	0.524	0.118	0.265	0.154^{**}	0.034
Christianity	1.6^{***}	0.000	1.38^{***}	0.000	1.22^{***}	0.000
Others	0.759^{**}	0.012	0.57^{***}	0.001	0.362^{***}	0.001
Caste [Scheduled Tribe =reference]						
Upper Caste Hindus	0.453	0.109	0.417^{**}	0.018	0.542^{***}	0.000
Other Backward Classes	0.254	0.224	0.154	0.194	0.182^{**}	0.019
Scheduled Caste	-0.080	0.695	-0.316^{**}	0.011	-0.121	0.151
Other	-0.014	0.950	-0.086	0.494	0.388^{***}	0.000
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]						
Share of members in age group 4-14 years	-0.009	0.983	-0.118	0.643	0.455^{***}	0.007
Share of members in age group 15-60 years	0.048	0.910	0.240	0.370	0.74^{***}	0.000
Share of members above the age of 60 years	0.340	0.569	0.513	0.166	0.791^{***}	0.001
Household Size	0.022	0.103	0.0429^{***}	0.000	0.0521^{***}	0.000
Drinking water is treated in some form (Yes=1, No=0)	0.699^{***}	0.000	0.649^{***}	0.000	0.626^{***}	0.000
Sanitation Facility [None, open fields= reference]						
Traditional latrine	0.51^{***}	0.001	0.568^{***}	0.000	0.739^{***}	0.000
VIP latrine	0.324	0.151	0.865^{***}	0.000	0.931^{***}	0.000
Flush toilet	0.492^{***}	0.002	0.565^{***}	0.000	0.846^{***}	0.000

Continued…

Quantiles→	0.1		0.2		0.4	
Variables ↓	Coeff	p-value	Coeff	p-value	Coeff	p-value
House has access to electricity (Yes=1, No=0)	0.046	0.665	0.211***	0.002	0.2***	0.000
Use clean cooking Fuel (Yes=1, No=0)	-0.189	0.149	-0.096	0.305	-0.27***	0.000
Age	0.003	0.666	0.0147***	0.001	0.036***	0.000
Completed Education level of the woman [Not literate=reference]						
Primary or Middle	0.222**	0.046	0.203***	0.003	0.215***	0.000
Secondary	0.068	0.661	0.005	0.966	0.118*	0.097
Higher secondary	0.120	0.594	0.141	0.365	-0.109	0.348
Graduate and Above	0.020	0.949	0.094	0.627	0.363***	0.004
Employment Status [Not in labour force and other employment=reference]						
Self-employed in agriculture	-0.286**	0.015	-0.118	0.115	-0.267***	0.000
Self-employed in agriculture and agricultural labour	-0.346*	0.072	-0.239***	0.034	-0.595***	0.000
Agricultural labour	-0.217	0.457	-0.149	0.443	-0.224**	0.071
Non-agricultural labour	-1.57***	0.002	-1.15***	0.000	-0.404	0.114
[Not Pregnant=Reference]						
pregnant but no antenatal access	1.89***	0.000	1.62***	0.000	1.76***	0.000
pregnant with antenatal access and going to doctor or nurse	0.238	0.517	0.623***	0.002	0.671***	0.000
pregnant with antenatal access and going to *dai* or others	2.22***	0.000	1.65***	0.000	1.71***	0.000
Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]						
ill but did not seek treatment	0.520	0.117	0.179	0.412	0.223	0.206
ill and goes to public doctor	-0.609*	0.056	-0.472**	0.010	-0.309**	0.013
ill and goes to private doctor	-0.872***	0.000	-0.666***	0.000	-0.435***	0.000
ill and seeks traditional help	-1.140*	0.091	-0.673*	0.066	-0.8***	0.000
Intercept	12.7***	0.000	11.5***	0.000	12.4***	0.000

Continued…

Quantiles→	0.6		0.8		0.9	
Variables ↓	Coeff	p-value	Coeff	p-value	Coeff	p-value
Log of Total Consumption Expenditure per person (Rs.)	0.117	0.149	0.239**	0.019	0.508**	0.020
(Predicted value of) Dietary Diversity Index	12.5***	0.000	15.6***	0.000	10.300	0.170
Allowed to purchase groceries (Yes=1, No=1)	-0.053	0.399	0.026	0.752	-0.321**	0.050
Eat with family members (Yes=1, No=0)	0.182***	0.005	0.257***	0.002	0.415**	0.013
Do not practice Purdah (Yes=1, No=0)	0.386***	0.000	0.231**	0.016	0.489***	0.008
Religion [Hindus=reference]						
Islam	0.070	0.558	0.345**	0.026	0.677**	0.029
Christianity	1.45***	0.000	0.919***	0.002	1.130*	0.051
Others	0.367**	0.034	0.458**	0.034	0.331	0.442
Caste [Scheduled Tribe =reference]						
Upper Caste Hindus	0.428**	0.037	0.169	0.544	0.640	0.294
Other Backward Classes	0.184	0.145	-0.081	0.654	-0.072	0.863
Scheduled Caste	-0.029	0.829	-0.355*	0.054	-0.793*	0.065
Other	0.270*	0.054	0.016	0.937	-0.377	0.411
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]						
Share of members in age group 4-14 years	0.574**	0.037	1.01***	0.007	-0.078	0.908
Share of members in age group 15-60 years	0.847***	0.003	0.983***	0.006	0.051	0.945
Share of members above the age of 60 years	1.43***	0.000	2.04***	0.000	1.020	0.249
Household Size	0.0428***	0.000	0.042***	0.001	0.030	0.227
Drinking water is purified in some form (Yes=1, No=0)	0.411***	0.000	0.352***	0.001	0.315	0.130
Sanitation Facility [None, open fields= reference]						
Traditional latrine	0.595***	0.000	1.06***	0.000	1.08***	0.000
VIP latrine	0.659***	0.000	0.82***	0.000	0.842**	0.023
Flush toilet	0.684***	0.000	0.933***	0.000	1.28***	0.000

Continued…

House has access to electricity (Yes=1, No=0)	0.207**	0.015	0.357***	0.002	0.217	0.360
Use clean cooking Fuel (Yes=1, No=0)	-0.109	0.317	0.486***	0.000	0.629**	0.020
Age	0.0537***	0.000	0.0821***	0.000	0.122***	0.000
Completed Education level of the woman [Not literate=reference]						
Primary or Middle	0.114	0.129	0.221**	0.017	0.247	0.192
Secondary	0.104	0.401	0.268	0.129	0.282	0.267
Higher secondary	-0.553***	0.001	-0.539**	0.021	0.187	0.716
Graduate and Above	-0.080	0.698	0.072	0.777	1.13**	0.040
Employment Status [Not in the labour force =1]						
Self-employed in agriculture	-0.31***	0.000	-0.468***	0.000	-0.741***	0.000
Self-employed in agriculture and agricultural labour	-0.508***	0.000	-0.568***	0.000	-1.1***	0.000
Agricultural labour	-0.363*	0.070	0.058	0.821	-1.16***	0.033
Non-agricultural labour	-0.855**	0.013	-1.32**	0.012	-1.540*	0.081
[Not Pregnant=Reference]						
pregnant but no antenatal access	1.5***	0.000	3.03***	0.000	2.88***	0.000
pregnant with antenatal access and going to doctor or nurse	0.568***	0.005	0.66***	0.002	1.11***	0.007
pregnant with antenatal access and going to dai or others	1.65***	0.000	0.748*	0.082	0.200	0.770
Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]						
ill but did not seek treatment	0.195	0.512	-0.470	0.179	-0.375	0.501
ill and goes to public doctor	-0.079	0.734	-0.076	0.760	0.475	0.418
ill and goes to private doctor	-0.37***	0.001	-0.39***	0.007	-0.58**	0.036
ill and seeks traditional help	-1.22***	0.003	-1.08**	0.032	-1.28**	0.042
Intercept	8.39***	0.000	5.46**	0.021	10.3**	0.041

Note:*p-value< 0.10; ** p-value <0.05; *** p-value <0.01.

Table 26b: Estimates of the State Dummy Variables from Quantile Regression (Second Stage)

State Codes	**0.1**		**0.2**		**0.4**		**0.6**		**0.8**		**0.9**	
	Coeff	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**
Himachal Pradesh	-0.736*	0.024	-0.845***	0.000	-0.99***	0.000	-1.64***	0.000	-0.971***	0.001	-1.38**	0.022
Uttarakhand	-1.66***	0.001	-1.61***	0.000	-2.19***	0.000	-3.32***	0.000	-3.65***	0.000	-3.62***	0.000
Punjab	0.245	0.537	-0.005	0.985	-0.385**	0.045	-0.180	0.527	0.991***	0.006	1.41**	0.049
Haryana	0.154	0.663	0.476**	0.031	0.477***	0.001	-0.160	0.492	0.141	0.641	-0.974*	0.089
Delhi	0.354	0.409	0.233	0.671	0.099	0.809	0.390	0.544	-1.080	0.149	-3.88**	0.018
Uttar Pradesh	-1.31***	0.000	-1.29***	0.000	-1.35***	0.000	-2.18***	0.000	-1.59***	0.000	-1.89***	0.003
Bihar	-0.748**	0.031	-0.762***	0.001	-0.976***	0.000	-2.09***	0.000	-1.95***	0.000	-2.52***	0.000
Jharkhand	-0.341	0.432	-0.551**	0.035	-0.759***	0.000	-1.42***	0.000	-1.54***	0.000	-2.69***	0.000
Rajasthan	-0.583*	0.055	-0.694***	0.000	-0.42***	0.002	-1.05***	0.000	-0.839***	0.003	-1.28**	0.022
Chhattisgarh	0.121	0.844	0.281	0.450	0.003	0.989	0.079	0.844	1.080*	0.051	-0.346	0.753
Madhya Pradesh	-0.979***	0.002	-0.863***	0.000	-0.765***	0.000	-1.53***	0.000	-1.3***	0.000	-1.95***	0.001
Northeast	-0.338	0.405	0.129	0.648	0.096	0.614	-0.096	0.747	-0.345	0.351	-1.86***	0.008
Assam	2.08***	0.000	1.92***	0.000	1.29***	0.000	0.118	0.633	-1.26***	0.000	-2.65***	0.000
West Bengal	-0.741**	0.016	-0.67***	0.001	-0.997***	0.000	-1.29***	0.000	-0.871***	0.002	-1.43**	0.011
Orissa	-1.07**	0.020	-.694**	0.014	-0.817***	0.000	-0.911***	0.002	-0.391	0.312	-1.71**	0.030
Gujarat	-1.41***	0.000	-1.32***	0.000	-1.8***	0.000	-2.69***	0.000	-2.87***	0.000	-2.62***	0.000
Maharashtra, Goa	-1.63***	0.000	-2.05***	0.000	-2.05***	0.000	-3.25***	0.000	-2.99***	0.000	-3.18***	0.000
Andhra Pradesh	-1.08***	0.002	-1.01***	0.000	-1.01***	0.000	-1.87***	0.000	-1.85***	0.000	-2.41***	0.000
Karnataka	-1.41***	0.000	-1.7***	0.000	-2.07***	0.000	-3.23***	0.000	-3.07***	0.000	-3.58***	0.000
Kerala	-0.771**	0.034	-0.425**	0.071	-0.541***	0.001	-0.510*	0.057	-0.029	0.933	-1.63**	0.017
Tamil Nadu	-1.55***	0.002	-0.564**	0.061	-0.387*	0.054	-1.35***	0.000	-1.83***	0.000	-2.66***	0.003
Pseudo R^2	0.0662		0.0729		0.0900		0.1004		0.1114		0.1336	

Chapter 9
CONCLUSIONS

Nutrition forms the basis of overall well-being of a person. It is even more important in the case of women since an undernourished woman gives birth to an undernourished child and thisresults in a vicious circle. Therefore, arresting the problem of undernourishment at different stages of the life-cycle becomes essential to reduce its huge burden observed in the Indian sub-continent. The inability of most of the countries in South Asia to reach the target set by the MDG to reduce undernourishment has brought renewed focus on this issue. There is enough evidence to show that structural transformation leading away from agricultural activities in general reduces poverty and hence undernutrition, and if all those involved with the agricultural sector also benefit in the process then the pace of reduction in undernutrition is faster in rural areas. This has resulted in increasing emphasis on rural areas and in particular in trying to harness the potential of agriculture to reducing undernutrition. It is well-known that all over the world agriculture continues to enjoy state support in order to sustain itself. In a country like India it is not just about support to agriculture but preserving agricultural diversity, addressing market imperfections and removal of certain malaise associated with deep rooted socio-cultural practices that need to be addressed simultaneously to have a more widespread impact on nutritional outcomes.

Prior studies in India have analyzed the impact of agriculture on undernutrition focusing mainly on children aged 0-3 years or 0-5 years determined by the data availability. The present study also follows a similar strand of empirical enquiry using a database that gives us scope to assess the relevance of farming activities but pertains to women's undernutrition outcomes rather than for children. In a given socio-economic setting, it is the adults who are mainly involved in the decisions of production, consumption and health seeking behavior at the household level. Hence it would be more appropriate to study the nature and intensity of linkage between farming and adult nutrition.

The empirical investigation in this study is based on the Indian Human Development Survey (IHDS) which contains fairly rich information both on economic and social aspects that includes details on agricultural production, income derived from agriculture, agricultural work carried out by women and also on livestock ownership which could contribute both to dietary quality as well as income generated from it.

This paper has attempted to explore the nature of relationship between agriculture and nutrition based on two components: nutrition intake (dietary diversity) and nutrition outcome (women's BMI). The nature of the data set is such that by using a large-scale survey for the first time, we have been able to explore the linkages between dietary diversity, features of farm production and women's BMI among farm households in rural India. However, the nature of the data set is also such that the nutrition intake is at the household level while the nutrition outcome is measured at the individual level. The methodological framework envisaged here resulted in establishing a relationship between agricultural components and dietary diversity which in turn influences women's BMI. Given that adults are more in control of the resources at the household level and women in particular are the main actors of change for children, a study of this nature gains significance.

This study finds that the likelihood of poor nutrition status for women as captured by BMI levels below 18.5 is the highest among non-agricultural wage labour households which face the largest brunt in the rural areas. If one were to understand what components within agriculture influence variations in the nutritional status, then the focus is to be on households involved in farming and allied activities. From such an analysis we find that agriculture variables influence dietary diversity, that is nutrition intakes, which in turn influence nutrition outcomes, that is BMI. Diversification either in terms of crop production or in terms of income improves dietary diversity and so does a higher share of sale of crops and ownership of cows and buffaloes after controlling for per capita income and wealth status, both of which also have significant positive influence on dietary diversity. The study also finds that if farm households are diversified in their income sources particularly towards salaried or businesses that are non-agricultural in nature then it improves dietary diversity. All of these variables improve affordability and access to diverse diets while higher the education of the household head, better is the dietary diversity mainlyfrom improved awareness.

BMI which pertains to an individual's nutrition status while influenced by dietary diversity, also has large impacts from access to basic amenities like good quality water, better sanitation facilities, a smoke-free cooking environment, an employment status that is less strenuous. After controlling for these variables, education and empowerment variables seem to have a less pronounced effect on the women's BMI, while there is an indication that women are able to seek better health care facilities when they feel the need to do so. Overall, we find that our results support the findings from conceptual studies that the components of agriculture are expected to improve nutrition intake with an equally important role for household's prosperity and environmental conditions that assist in maintaining a good health for the individual. Unlike some of the earlier studies, we do find better possibilities of connection between agriculture and nutrition through production diversity, dietary diversity and income diversity (from farm and non-farm sources).

This study was carried out on a data set that is a decade old now. In the past decade several changes have taken place, and prominent among these are larger diversification among farm households, increasing employment in rural non-farm employment and a very recent turnaround in non-agricultural employment thereby allowing possibilities for absorbing the surplus labour from agriculture (Mehrotra *et al* 2013). National Income in India grew at an annual rate of 5.6 percent during the Ninth Plan Period (1997-2002), 7.6 percent in Tenth (2002-2007) and 7.8 percent in Eleventh (2006-12). The agricultural sector during these periods grew at an annual rate of 2.5 percent, 2.4 percent and 3.7 percent respectively. The last decade has seen a mixed performance of the economy with first half belonging to economic growth that was high while the second half showed a modest growth. In this period the agricultural growth has been modest but below the targeted rates for the Eleventh Plan period. Unfortunately there has been no country wide data available on nutrition outcomes between 2004 and 2011 and hence making it difficult to track the changes in it during a period of varied economic growth in India.

With the availability of more recent IHDS data for the year 2011-12, it may be possible to analyse the impact of these changes on the nutrition outcomes. Since this is a panel data set the tracing the changes for the same set of women would help in documenting the impacts of economic growth in general and the structural changes within agricultural sector more effectively. This study focused on some aspects of farming that influence nutrition intakes, and it would also be relevant to use information from these large scale surveys to understand factors that explain variations in cropping diversity, ownership and management of livestock and other allied agricultural activities.

The improvement in India's score from 31.2 in 1999-2000 to 24.2 in 2012 of the Global Hunger Index is an important development. With the availability of data from District Level Household and Facility Survey for 2012-13, Rapid Survey of Children for 2013-14 and Annual Health Survey, the state level changes in child underweight shows that many states have improved between 2004 and 2014 while a few have deteriorated. Further analysis on the reasons behind these changes would help in focusing on policies that have a profound impact and also to delineate factors that are relevant for agriculture vis-à-vis non-agriculture.

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Appendix Tables

Table A.1: Estimates of the State Level Dummy Variables for the Results in Table 21: CED, All Rural Households

Variables	Variant-1		Variant-2		Variant-3	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
Jammu & Kashmir	0.0716	0.627	0.0145	0.922	-0.0280	0.851
Himachal Pradesh	0.2638**	0.016	0.2483**	0.022	0.2146*	0.051
Uttarakhand	0.7454***	0.000	0.7260***	0.000	0.6943***	0.000
Haryana	-0.0080	0.942	0.0302	0.784	0.0198	0.857
Delhi	-0.7097*	0.098	-0.7012	0.104	-0.7106*	0.099
Uttar Pradesh	0.3731***	0.001	0.3411***	0.002	0.3034***	0.005
Bihar	0.1646	0.156	0.0860	0.457	0.0593	0.608
Jharkhand	0.3232***	0.009	0.2644**	0.037	0.2246*	0.075
Rajasthan	0.0831	0.434	0.0970	0.361	0.0548	0.605
Chhattisgarh	0.3272**	0.011	0.3198**	0.014	0.2792**	0.030
Madhya Pradesh	0.2473**	0.021	0.2103*	0.051	0.1782*	0.097
Northeast	-0.1081	0.476	-0.1673	0.273	-0.1841	0.228
Assam	-1.046***	0.000	-1.096***	0.000	-1.118***	0.000
West Bengal	0.3510***	0.001	0.2925***	0.009	0.2737**	0.014
Orissa	0.4484***	0.000	0.4044***	0.001	0.3729***	0.002
Gujarat	0.5303***	0.000	0.5041***	0.000	0.4869***	0.000
Maharashtra, Goa	0.6572***	0.000	0.6077***	0.000	0.5839***	0.000
Andhra Pradesh	0.4185***	0.000	0.3598***	0.001	0.3504***	0.001
Karnataka	0.7153***	0.000	0.6520***	0.000	0.6354***	0.000
Kerala	0.1591	0.226	0.1160	0.377	0.1107	0.399
Tamil Nadu	0.3230*	0.052	0.2836*	0.073	0.2767*	0.083

Table A.2: Estimates of the State Level Dummy Variables for the Results in Table 23: CED, Farm Households

	Variant-1		Variant-2		Variant-3	
	Coeff.	**p-value**	**Coeff.**	**p-value**	**Coeff.**	**p-value**
Jammu & Kashmir	0.0184	0.933	0.0891	0.680	-0.0193	0.931
Himachal Pradesh	0.1570	0.402	0.2506	0.164	0.2212	0.227
Uttarakhand	0.6710***	0.002	0.7468***	0.001	0.7286***	0.001
Haryana	0.0813	0.677	0.0532	0.787	-0.0051	0.980
Uttar Pradesh	0.4095**	0.024	0.3613**	0.047	0.3364*	0.068
Bihar	0.1861	0.329	0.0999	0.602	0.0751	0.699
Jharkhand	0.2746	0.174	0.2821	0.162	0.2436	0.234
Rajasthan	0.2431	0.176	0.1573	0.385	0.1169	0.526
Chhattisgarh	0.3140	0.121	0.3751*	0.062	0.3505*	0.084
Madhya Pradesh	0.2784	0.126	0.2836	0.120	0.2573	0.164
Northeast	-0.0153	0.956	0.0633	0.821	0.0946	0.736
Assam	-1.3661***	0.001	-1.374***	0.001	-1.330***	0.001
West Bengal	0.3014	0.103	0.3337*	0.073	0.3308*	0.078
Orissa	0.4618**	0.016	0.4960**	0.010	0.4671**	0.017
Gujarat	0.5307***	0.005	0.5418***	0.006	0.5026**	0.011
Maharashtra, Goa	0.6315***	0.000	0.7049***	0.000	0.6877***	0.000
Andhra Pradesh	0.2967	0.131	0.3957**	0.047	0.3543*	0.079
Karnataka	0.5915***	0.001	0.7514***	0.000	0.7580***	0.000
Kerala	0.2605	0.291	0.4168*	0.089	0.3764	0.137
Tamil Nadu	0.2164	0.376	0.3953*	0.098	0.3786	0.124

Table A.3: Estimates of Variant 1 (in Table 23) Using OLS and Quantile Regression for BMI

Quantiles→	**OLS**		**0.1**		**0.2**	
Variables↓	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**
Production Diversity Index	-0.070	0.634	-0.266	0.141	-0.064	0.701
Logarithm of total area cultivated in acres	0.023	0.575	0.102**	0.044	0.055	0.243
Possess cows and buffaloes (Yes/no)	-0.053	0.466	0.013	0.881	-0.123	0.138
Possess goats and sheep	-0.14**	0.048	-0.145*	0.091	-0.19*	0.013
Possess poultry animals	0.007	0.921	0.084	0.302	-0.025	0.739
Logarithm of net farm income	-0.25***	0.001	-0.160*	0.072	-0.17**	0.041
Share of Sale of Own Produce	0.152	0.143	-0.007	0.958	0.041	0.730
Log of Household Income per person (Rs.)	0.26***	0.002	0.152	0.129	0.25***	0.007
Log of Total Consumption Expenditure per person (Rs.)	0.20***	0.006	-0.071	0.426	-0.104	0.209
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]						
Quintile 2 or 'Poor'	0.237**	0.020	0.015	0.906	0.005	0.968
Quintile 3 or 'Middle'	0.58***	0.000	0.249*	0.068	0.27**	0.036
Quintile 4 or 'Rich'	0.63***	0.000	0.240	0.115	0.35**	0.012
Quintile 5 or 'Richest'	0.92***	0.000	0.66***	0.000	0.68***	0.000
Share of total agricultural income	0.99***	0.000	0.451*	0.084	0.65***	0.007
Share of non-agricultural wage income	-0.004	0.979	0.046	0.812	-0.147	0.414
Dietary Diversity Index	0.581	0.237	0.696	0.249	0.463	0.408
Women's Status Variables						
Allowed to purchase groceries (Yes=1, No=1)	-0.072	0.283	0.089	0.278	0.114	0.135
Eat with family members (Yes=1, No=0)	0.21***	0.004	0.076	0.387	0.122	0.134
Do not practice Purdah (Yes=1, No=0)	0.27***	0.001	0.142	0.163	0.16*	0.089
Religion [Hindus=reference]						
Islam	0.28**	0.028	0.211	0.170	0.168	0.238
Christianity	0.91***	0.004	1.44***	0.000	1.12***	0.002
Other religions	0.47**	0.023	0.650**	0.011	0.384	0.103
Caste [Scheduled Tribe =reference]						
Upper Caste Hindus	0.62**	0.001	0.403*	0.074	0.43**	0.036
Other Backward Classes	0.26**	0.031	0.248*	0.095	0.180	0.192

Table A.3 Estimates of Variant 1 (in Table 23) using OLS and quantile regression for BMI, Continued

Scheduled Caste	-0.153	0.248	-0.030	0.856	-0.27*	0.072
Other castes	0.23*	0.096	-0.008	0.960	0.046	0.763
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]						
Share of members in age group 4-14	0.350	0.230	-0.253	0.480	-0.152	0.646
Share of members in age group 15-	0.363	0.237	-0.283	0.455	0.218	0.533
Share of members above the age of	0.83**	0.047	0.258	0.615	0.610	0.200
Household Size	0.05***	0.000	0.016	0.400	0.04**	0.011
Drinking water is treated in some	0.49***	0.000	0.792***	0.000	0.77***	0.000
Sanitation Facility [None, open fields= reference]						
Traditional latrine	0.72***	0.000	0.618***	0.000	0.50***	0.000
VIP latrine	0.62***	0.000	0.355*	0.077	0.78***	0.000
Flush toilet	0.75***	0.000	0.275*	0.058	0.42***	0.002
Quantiles→	**OLS**		**0.1**		**0.2**	
Variables↓	**Coeffs**	**p-**	**Coeffs.**	**p-**	**Coeffs.**	**p-**
House has access to electricity	0.100	0.228	0.056	0.584	0.107	0.260
Use clean cooking Fuel (Yes=1,	0.187	0.132	-0.202	0.187	-0.220	0.121
Age	0.06***	0.000	0.004	0.505	0.02***	0.003
Completed Education level of the woman [Not literate=reference]						
Primary or Middle	0.22***	0.003	0.077	0.414	0.16*	0.068
Secondary	0.22*	0.071	-0.038	0.793	-0.070	0.603
Higher secondary	-0.03	0.889	-0.025	0.92	-0.023	0.919
Graduate and Above	0.269	0.334	0.007	0.984	-0.138	0.664
Employment Status [Not in the labour force =Reference]						
Self-employed in agriculture	-0.37***	0.000	-0.228**	0.024	-0.005	0.957
Self-employed in agriculture and	-0.62***	0.000	-0.33***	0.022	-0.198	0.143
Agricultural labour	-0.42*	0.089	-0.309	0.303	-0.176	0.527
Non-agricultural labour	-0.96***	0.030	-1.94***	0.000	-0.98*	0.052
Pregnancy and Antenatal Care Access [Not Pregnant=Reference]						
pregnant but no antenatal access	2.04***	0.000	1.95**	0.000	1.70***	0.000
pregnant with antenatal access and	0.56***	0.003	0.370	0.110	0.62***	0.004

Contd...Table A.3

Table A.3 Estimates of Variant 1 (in Table 23) using OLS and quantile regression for BMI, Continued..

Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]						
ill but did not seek treatment	0.124	0.701	0.476	0.232	0.046	0.900
ill and goes to public doctor	-0.289	0.193	-0.414	0.129	-0.47*	0.063
ill and goes to private doctor	-0.40***	0.001	-0.72***	0.000	-0.65***	0.000
ill and seeks traditional help	-1.04**	0.039	-1.12*	0.072	-0.661	0.251
Intercept	16.06***	0.000	16.93***	0.000	16.33***	0.000

Quantiles→	**0.4**		**0.6**		**0.8**	
Variables↓	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**	**Coeffs.**	**p-value**
Production Diversity Index	-0.051	0.764	0.005	0.978	0.178	0.461
Logarithm of total area cultivated in acres	0.008	0.866	0.046	0.320	-0.024	0.726
Possess cows and buffaloes (Yes/no)	-0.168**	0.046	-0.038	0.637	0.009	0.940
Possess goats and sheep	-0.212***	0.008	-0.226***	0.004	0.003	0.976
Possess poultry animals	-0.067	0.380	-0.115	0.120	0.006	0.956
Logarithm of net farm income	-0.255***	0.002	-0.186**	0.021	-0.256**	0.031
Share of Sale of Own Produce	0.086	0.474	0.110	0.337	0.312*	0.066
Log of Household Income per person (Rs.)	0.311***	0.001	0.169*	0.063	0.186	0.165
Log of Total Consumption Expenditure per person (Rs.)	0.137	0.103	0.166	0.040	0.422***	0.000
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]						
Quintile 2 or 'Poor'	0.056	0.638	0.351***	0.002	0.476***	0.004
Quintile 3 or 'Middle'	0.306**	0.017	0.589***	0.000	0.742***	0.000
Quintile 4 or 'Rich'	0.501***	0.000	0.669***	0.000	0.776***	0.000
Quintile 5 or 'Richest'	0.499***	0.004	1.044***	0.000	1.382***	0.000
Share of total agricultural income	1.019***	0.000	0.867***	0.000	1.125***	0.001
Share of non-agricultural wage income	0.053	0.773	-0.071	0.688	-0.221	0.394
Dietary Diversity Index	0.638	0.261	1.008*	0.065	0.646	0.422
Women's Status Variables						
Allowed to purchase groceries (Yes=1, No=1)	-0.043	0.576	-0.109	0.144	-0.029	0.795

Quantiles→	0.4		0.6		0.8	
Variables↓	Coeffs.	p-value	Coeffs.	p-value	Coeffs.	p-value
Eat with family members (Yes=1, No=0)	0.165**	0.045	0.199**	0.012	0.166	0.154
Do not practice Purdah (Yes=1, No=0)	0.393***	0.000	0.324***	0.000	0.275**	0.043
Religion [Hindus=reference]						
Islam	0.112	0.437	0.229	0.101	0.524**	0.011
Christianity	1.404***	0.000	1.561***	0.000	0.883*	0.086
Other religions	0.499**	0.037	0.287	0.213	0.128	0.707
Caste [Scheduled Tribe =reference]						
Upper Caste Hindus	0.712***	0.001	0.649***	0.001	0.394	0.191
Other Backward Classes	0.316**	0.024	0.306**	0.023	0.161	0.416
Scheduled Caste	-0.041	0.786	0.013	0.931	-0.019	0.930
Other castes	0.493***	0.002	0.338	0.024	0.189	0.392
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]						
Share of members in age group 4-14 years	0.421	0.211	0.272	0.402	0.747	0.118
Share of members in age group 15-60 years	0.529	0.136	0.621*	0.069	0.939*	0.062
Share of members above the age of 60 years	0.795	0.100	1.142**	0.014	1.931***	0.005
Household Size	0.079***	0.000	0.048***	0.005	0.058**	0.019

Quantiles→	0.4		0.6		0.8	
Variables↓	Coeffs.	p-value	Coeffs.	p-value	Coeffs.	p-
Drinking water is treated in some	0.562***	0.000	0.473***	0.000	0.444***	0.009
Sanitation Facility [None, open fields= reference]						
Traditional latrine	0.732***	0.000	0.584***	0.000	0.803***	0.000
VIP latrine	0.842***	0.000	0.628***	0.001	0.568**	0.034
Flush toilet	0.766***	0.000	0.699***	0.000	0.664***	0.001
House has access to electricity	0.102	0.286	0.129	0.163	0.220	0.105
Use clean cooking Fuel (Yes=1,	-0.241*	0.094	-0.055	0.692	0.438**	0.031
Age	0.035***	0.000	0.055***	0.000	0.078***	0.000
Completed Education level of the woman [Not literate=reference]						

Quantiles→	0.4		0.6		0.8	
Variables↓	Coeffs.	p-value	Coeffs.	p-value	Coeffs.	p-
Primary or Middle	0.183**	0.039	0.035	0.679	0.147	0.242
Secondary	-0.041	0.768	-0.047	0.721	0.327*	0.094
Higher secondary	-0.380*	0.093	-0.486**	0.026	-0.392	0.223
Graduate and Above	0.189	0.556	-0.036	0.906	0.208	0.647
Employment Status [Not in the labour force =Reference]						
Self-employed in agriculture	-0.200**	0.035	-0.302***	0.001	-0.469***	0.000
Self-employed in agriculture and	-0.594***	0.000	-0.446***	0.001	-0.597***	0.002
Agricultural labour	-0.256	0.365	-0.234	0.389	-0.328	0.413
Non-agricultural labour	0.012	0.982	-0.547	0.269	-1.136	0.119
Pregnancy and Antenatal Care Access [Not Pregnant=Reference]						
pregnant but no antenatal access	1.410***	0.000	1.900***	0.000	3.002***	0.000
pregnant with antenatal access	0.610***	0.005	0.600***	0.004	0.477	0.122
pregnant with antenatal access	2.010***	0.001	1.902***	0.001	0.951	0.255
Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]						
ill but did not seek treatment	0.152	0.686	0.332	0.357	-0.394	0.459
ill and goes to public doctor	-0.506**	0.048	-0.393	0.112	-0.269	0.459
ill and goes to private doctor	-0.422***	0.002	-0.288**	0.028	-0.229	0.236
ill and seeks traditional help	-0.629	0.281	-1.317**	0.019	-0.695	0.401
Intercept	14.755***	0.000	16.158***	0.000	16.952***	0.000

Table A.4: Estimates of the state level dummy variables for the results in Table 24: dietary diversity equation (First Stage)

	Coeff.	***p-value***
Jammu & Kashmir	-0.007	0.309
Himachal Pradesh	0.025***	0.000
Uttarakhand	0.037***	0.000
Haryana	-0.044***	0.000
Uttar Pradesh	0.029***	0.000
Bihar	0.025***	0.000
Jharkhand	-0.025***	0.001
Rajasthan	0.007	0.296
Chhattisgarh	-0.145***	0.000
Madhya Pradesh	0.000	0.952
Northeast	-0.034***	0.002
Assam	0.002	0.715
West Bengal	-0.022***	0.001
Orissa	-0.081***	0.000
Gujarat	0.052***	0.000
Maharashtra, Goa	0.058	0.000
Andhra Pradesh	0.014**	0.023
Karnataka	0.049***	0.000
Kerala	0.008	0.259
Tamil Nadu	0.001	0.902

Table A.5a: Estimates from 3sls for Dietary Diversity Equation (First Stage)

Variables	Coefficient	p-values
Production diversity index	0.0063**	0.034
Log of total land area cultivated (acres)	0.0038***	0.000
Log of total Agricultural Income (Rs.)	-0.0059***	0.000
Share of Sale of Own Produce	0.0050**	0.015
Ownership of livestock [draft animals is the reference category]		
cows/buffaloes (Yes=1, No=0)	0.0057***	0.000
Small ruminants (Yes=1, No=0)	-0.0018	0.199
Poultry and others (Yes=1, No=0)	0.0012	0.377
Log of Household Income per person (Rs.)	0.0066***	0.000
Log of Total Consumption Expenditure per person (Rs.)	0.0156***	0.000
Asset Quintile Groups [Quintile 1 or 'Poorest'=reference]		
Quintile 2 or 'Poor'	0.0147***	0.000
Quintile 3 or 'Middle'	0.0228***	0.000
Quintile 4 or 'Rich'	0.0301***	0.000
Quintile 5 or 'Richest'	0.0302***	0.000
Share of Agricultural Income in Total Income	-0.0054	0.207
Share of Non-agricultural Wage Income	-0.0165***	0.000
Religion of the household head [Hindus=reference]		
Islam	0.0090***	0.000
Christianity	-0.0037	0.567
Others	-0.0107**	0.013
Caste of the household head [Scheduled Tribe =reference]		
Upper Caste Hindus	0.0278***	0.000
Other Backward Classes	0.0192***	0.000
Scheduled Caste	0.0155***	0.000
Other	0.0197***	0.000
Education of the household head [Not literate=reference]		
Primary or Middle	0.0041**	0.018
Secondary	0.0086***	0.000
Higher secondary	0.0083***	0.001
Graduate and Above	0.0076***	0.006
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]		
Share of members in age group 4-14 years	-0.0101*	0.056
Share of members in age group 15-60 years	-0.0158***	0.005
Share of members above the age of 60 years	-0.0115	0.165
Household Size	-0.0006**	0.040
Intercept	0.6703***	0.000

Table A.5b: Estimates from 3sls for BMI (2nd stage)

Variables	Coefficient	p-values
Log of Total Consumption Expenditure per person (Rs.)	0.145	0.118
(Predicted value of) Dietary Diversity Index	9.597***	0.000
Allowed to purchase groceries (Yes=1, No=1)	-0.070	0.295
Eat with family members (Yes=1, No=0)	0.208***	0.003
Do not practice Purdah (Yes=1, No=0)	0.266***	0.001
Religion [Hindus=reference]		
Islam	0.164	0.197
Christianity	1.019***	0.001
Others	0.647***	0.002
Caste [Scheduled Tribe =reference]		
Upper Caste Hindus	0.499**	0.014
Other Backward Classes	0.173	0.204
Scheduled Caste	-0.246*	0.081
Other	0.1624	0.278
Household Composition, share of members in different age group [children in age group 0-4 years= excluded group]		
Share of members in age group 4-14 years	0.4610	0.119
Share of members in age group 15-60 years	0.561*	0.070
Share of members above the age of 60 years	1.030**	0.015
Household Size	0.038***	0.001
Drinking water is treated in some form (Yes=1, No=0)	0.477***	0.000
Sanitation Facility [None, open fields= reference]		
Traditional latrine	0.792***	0.000
VIP latrine	0.702***	0.000
Flush toilet	0.821***	0.000
House has access to electricity (Yes=1, No=0)	0.232***	0.005
Use clean cooking Fuel (Yes=1, No=0)	0.192	0.118
Age	0.058***	0.000
Completed Education level of the woman [Not literate=reference]		
Primary or Middle	0.253***	0.001
Secondary	0.232*	0.055
Higher secondary	0.009	0.962
Graduate and Above	0.265	0.337
Employment Status [Not in labour force and other employment=reference]		
Self-employed in agriculture	-0.371***	0.000
Self-employed in agriculture and agricultural labour	-0.6104***	0.000
Agricultural labour	-0.3923	0.106
Non-agricultural labour	-1.131**	0.012

Continued…

Table A.5b: Estimates from 3sls BMI (2^{nd} stage), continued

[Not Pregnant=Reference]		
pregnant but no antenatal access	1.986***	0.000
pregnant with antenatal access and going to doctor or nurse	0.567***	0.003
pregnant with antenatal access and going to *dai* or others	1.543***	0.003
Shorter term morbidity or illness reported in the last 30 days [Not Ill =Reference]		
ill but did not seek treatment	0.084	0.795
ill and goes to public doctor	-0.318	0.152
ill and goes to private doctor	-0.428***	0.000
ill and seeks traditional help	-1.074**	0.034
Intercept	9.884***	0.000

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