Role of Human Capital, Crop Diversification on Women's Nutritional Status in Sat[1] India Using Dynasty Panel Data

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Abstract

Close linkages between agriculture, nutrition and health have been established in the literature, especially recognizing the gender roles in achieving improved nutrition and health. This paper contributes important insights regarding the nutritional status of adult women engaged in agriculture and examines the interaction of human capital (especially education), agricultural diversification, consumption expenditure, and lifestyle choices on their nutritional status. The Body Mass Index (BMI) is used as a proxy for assessing the nutritional status of women. Panel data from the Village Dynamics Studies in South Asia (VDSA) covering households in six villages of semi-arid tropics (SAT) of India over the last decade (2005 to 2014) is harnessed to construct a dynasty household matrix and systematize the panel data analysis. Both descriptive and econometric analyses are carried out to examine interaction between nutritional status and factors like education, agricultural diversification, lifestyle, household expenditure, per-capita income of the households. Complementary panel logistic regression analysis using the VDSA household dynasty data suggests that education (or investments in human capital) and per capita income among women have significant positive impacts on lowering malnutrition. The results of model-1 revealed that married women and women belonging to ages more than 34 years are likely to be less underweight compared to unmarried and young women. Similar observation were drawn with women members with higher per-capita income. Likewise, the model-2 results show that women between the ages 25 and above and with higher per capita income are also likely to be overweight. Households with low and medium standard of living are likely to have less overweight women compared to households with high standard of living. The paper concludes that agricultural diversification and education of women do affect women nutritional status. Ultimately, it alerts agricultural planners, researchers and development investors to package crop diversification and lifestyle interventions with targeted nutrition goals.

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Introduction

Agriculture is dominated by smallholders-many of whom suffer from poverty, malnutrition and poor health- and faces environmental challenges. In some regions, smallholder agriculture is not growing enough to keep up with rising demand for food and to provide farmers with adequate demand for food and to provide farmers with adequate incomes. Women, who make up the majority of workers on smallholder farms, are particularly vulnerable, because they are also responsible for food and nutrition security and care for the family.

Availability, accessibility, affordability and absorption of proper nutrition is of extreme importance for human growth and mental development in the early years of life. Lack of right amount of the vitamins, minerals and other nutrients lead to the development of malnutrition. Although India has seen strong economic growth over the past 20 years with 10-14 annual growth rates, malnutrition continues to be among the highest in the world in children under five years of age. The magnitude of micronutrient deficiency is particularly alarming among children, women of reproductive age and pregnant and nursing mothers. Malnutrition is more common in India than in Sub-Saharan Africa. India ranks 97th as per Global Hunger Index (GHI) Report (2016) with a GHI score of 28.5 in 2016. The rate continues to be serious inspite of progress made from 1992 (GHI score in 1992 = 46.6). The rate of malnutrition among India's children is almost five folds more than in China and twice those in Sub-Saharan Africa.

Women are vulnerable to malnutrition, for social and biological reasons, throughout their life-cycle. As children, in some parts of the world, girls are discriminated against in access to health care, to food and education, and in other ways. As teenagers, they risk early pregnancy and suffer more risk from retarded growth than boys. Reproductive-aged women are subject to numerous stresses affecting their health and well-being. Elderly women in many societies are deprived. Malnutrition in women may be a problem insufficiently recognized and inadequately documented.

To assess level and trends in women's nutritional status the following data is available: anthropometry; anemia; incidences of low birth weight; and maternal mortality. It is clear that malnutrition among women is a problem that has been under-recognized, and should now take greater priority.

Much of the literature on gender and poverty is impressionistic and anecdotal, due in large part to the failure of many surveys to disaggregate and present information by gender (McGuire and Popkin 1990).The intergenerational patterns are particularly strong for girls. The low status of women leads to an undervaluation of their time and to underinvestment in their education. This in turn leads to wide gender differentials in wage rates for the same activity.

There is strong evidence from India that this adult wage male-female differential is partly responsible for the relative underinvestment in girls (Rosenzweig and Schultz 1982). Girl's education is described by Ramalingaswami et al. (1997) as the "key of keys" to reducing gender inequalities. They conclude that these inequalities are particularly important for child nutrition: "the exceptionally high rates of malnutrition in South Asia are rooted deep in the soil of inequality given its impact on health, education and economic productivity, persistent under-nutrition" is a major obstacle to human development, impacting India's much-awaited demographic dividend and the country's prospects for future economic growth. In order to overcome this distressing situation of malnutrition, long-term efforts include fostering nutritionally dense agriculture by increasing yields and making sure negative consequences affecting yields are minimized.

It is also acknowledged that the complex relationships between agricultural productivity, nutrition, improved health and empowerment of individuals, households and communities are affected by gender norms (Chung, 2013). It is now recognized that a gendered approach to nutrition-agriculture linkages is essential to understand how programs or policies will affect males and females differently and in turn, the effect this will have on the health and nutritional status on males and females within the household. The critical agents of transformation and change especially in the Semi Arid Tropics (SAT) regions are small holder agricultural producers as well as consumers –both women and men.

Investment in education and health of women is inextricably linked to improvement in nutrition of women and children (Nabarro, 2012). The national demographic survey findings of India and Pakistan reveal that with increase in level of education of women, there is significant reduction in percentage of children with stunting as well as other important determinants of women's nutrition such as percentage with low age of marriage and age of first conception as well as percent of mothers with low Body Mass Index (BMI) and suffering domestic violence (Arnold et al., 2005). Education empowers women, more so secondary education has seen enhancing the decision-making capacity and power of women.

Women's vulnerability results from their special role not only as food producers, but also from their unique reproductive roles, and the associated demands of motherhood. Health and nutrition shocks that adversely affect women not only affect their productive role as workers in the agricultural sector, but also impact their joint production role as caregivers for their children, and thus induce a recurrent and intergenerational cycle of crisis and deprivation. In terms of accessing essential inputs for productive agriculture, women face serious barriers in obtaining credit, machinery, education (agricultural knowledge), and improved inputs (Gladwin et al. 1997;Quisumbing and Pandolfelli 2010).

In concurrence with IFPRI (Macmillan et al, 2011), while there is a substantial body of literature focusing on agricultural development, there is an extraordinarily thin evidence base for the links between major agriculture-related institutional, technological, and policy shifts in the past two decades and the nutritional status of women and children. It is imperative to

address this gap through panel datasets which will allow for spatial, temporal, and analysis disaggregated by sex.

Data and Methods

Conceptual Framework

The conceptual linkage between increased human capital and improved nutritional status appears straight forward ; yet, devising research strategies that lead to real change has proved difficult. This paper seeks to update knowledge of the role that the human capital (education) play in the nutritional status of the rural women. Specifically, it examines two linkages – a. the level/state of education in the study area and its impact on nutrition, and b. the role of crop diversification to reduce malnutrition. These two linkages are addressed through a dynasty level analysis of households in six rural villages in the SAT. The ultimate purpose is to discuss the menu of options available to researchers interested in strengthening the link between human capital, crop diversification and nutritional well - being.

A Gendered Conceptual Framework of the Determinants of Nutrition Outcomes has been adapted and represented in figure 1. Women with control over resources and access to better lifestyle tend to have a larger say in how the household allocates resources, and women are typically more likely to skew resources to the production of nutrition. Education is crucial for income generation and behavioral change which leads to better nutrition. Therefore it is important to investigate the interaction and consequences between factors like education, crop diversity, lifestyle, and income and consumption expenditure with women's nutritional status.

Data

This paper explores the extent to which human capital (with special focus on education) and crop diversification, in terms of crop diversity index, affects women's nutritional status. Drawing extensively on data from ICRISAT's Village Level Studies (VLS), it includes insights from two villages from each of three districts spanning two states Telangana and Maharashtra, in SAT India. Longitudinal panel surveys like VLS at the individual, household- and village level are proving to be a powerful tool for understanding gender dynamics in vulnerable, marginal settings where smallholder farmers play a dominant role in the village and household economy.

Evidence indicates that agricultural interventions involve women are more likely to use the resulting increase in income for improving household security through positive influence in bargaining power of women within households and in making nutritionally appropriate choices with regard to household expenditure (Gillespie et al., 2012; Bold et al. 2013)

The VLS database has been called the "gene bank of social scientists," as it is comprised of a wide range of data intensively collected from an original set of 40 households in each village starting in 1975 and follows the same households as much as possible until the present

time. In the present study, we have constructed the dynasty household matrix using both first generation VLS and the second generation Village Dynamics Studies in South Asia (VDSA[1]) data to capture the intergenerational effect on sample households.

Construction of Dynasty household dataset/matrix: The term 'dynasty' refers to the set of households included in subsequent rounds of the survey whose members belonged to the same household in the baseline survey. The sample households (including the split offs) surveyed from 1975 to 2014 in six villages namely Aurepalle, Dokur of Telangana and Kanzara, Kinkhed, Kalman and Shirapur of Maharashtra were considered for this analysis. Due to attrition households were replaced with new households having similar characteristics or belonging to the same land holding group. There were also some changes in the sample households and sample sizes over time. Due to this 1975 – 1979, 1983, 2005 – 2014 years were considered in this analysis since only in these years, the respondents belong to the same families or dynasties. Respondents belonging to the same family tree, either parent, children or siblings are considered as belonging to the same dynasty. The total number of dynasty households abstracted are 336 of which, 62 percent are split-off households[2] and 32 percent original households. The 336 households are used to construct the dynasty household matrix and systematize the panel data analysis. The data used for the analysis is from the year 2005 to 2014 and 5982 observations for women between ages 15 to 50 years are considered in the sample. BMI is used as a proxy for the assessment of the nutritional status of women among sample households. As per the WHO (1995) recommendations, the BMI variable was categorized into six groups for preliminary analysis:

severely thin (BMI, <16.00 kg/m^2),

moderately thin (BMI, 16.00–16.99 kg/m^2),

mildly thin (BMI, 17.00–18.49 kg/m^2),

normal weight (BMI, 18.5–24.9 kg/m^2),

overweight (BMI, 25.0–29.9 kg/m^2) or

obese (BMI ≥30 kg/m^2).

In this paper, the six BMI groups were combined to three groups as follows: underweight (BMI<18.49 kg/m^2); normal (BMI, 18.5–24.9 kg/m^2) and overweight and obese (BMI, ≥25 kg/m^2).

Methodological and Analytical Framework

An important component to optimal health is life style index. Several commodities for lifestyle improvement have independently shown to improve standard of living. The simultaneous implementation of multiple lifestyle is thought to be difficult, and the current

[1] Funded by Bill & Melinda Gates Foundation
[2] Split-off household: consisting of households of individuals who had separated from the old households

literature lacks the assessment of multiple lifestyle indicators simultaneously with respect to the effect on standard of living. This study tries to quantify multiple indicators into a single index value called Life style index. This value was measured taking into account residential status, access to toilet, access to electricity, access to drinking water, access to television and star connection, access to LPG/cooking gas and internet connection. Based on the indicators, the households were classified into three categories low, medium and high life style and analysis tried to correlate an improvement in this value to an improved nutritional status (BMI).

Per capita household 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. Per capita household income in current USD is used in the analysis.

Annual per capita consumption expenditure is defined as 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 (Viswanathan, 2015). 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.

Analytical methods used to quantify the role of human and physical capital, crop diversification, income, expenditure, landholding and its effect on women nutritional status and their overtime compound growth rate are estimated. Human Capital especially education is defined as number of years spent in formal school. Crop diversification is measured as an index called Crop Production Diversity Index. It is described as an area 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. As already mentioned, nutritional status of women is measured using the BMI. Factors influencing nutritional status (such as household and individual characteristics, resource endowments, effects of farm size, village infrastructure) were identified and their relative contribution was estimated at the household level using a multivariate random effect panel data Logit model. The details of variables used and their description have been documented in table 1. The results were analyzed using the panel logistic regression analysis showing the effects of selected variables on women being underweight and women being overweight compared to normal BMI among dynasty households members for the year 2005 to 2014.

Results and Discussion

The causes of nutritional deprivation are diverse, multi-sectoral, interrelated and entail biological, health, social, cultural and economic factors, and their influences operate at various

levels such as child, family, household, community and nation. Both descriptive and econometric analyses are carried out to examine interaction between nutritional status of women and factors like education, agricultural diversification, lifestyle, household expenditure, per-capita income of the households. In below sections the results mainly focus on the nutritional status (BMI) of individuals across gender and location, the interaction between caste (social groups), class, income, expenditure patterns, education, crop diversity and their impact on women nutritional status are discussed. The determinant of women's nutritional status considering some selected variables have been discussed in the last section of results and discussion.

Trends in Nutritional Status by Gender and Location

The present paper mainly focused on the change of adult female nutritional status and its interaction with different factors. Before considering the disaggregate level analysis it is important to consider the overall picture of nutritional status across gender and locations. Table-2 indicates that percentage of adults – both women and men - having normal BMI shows an increasing trend (Growth rate for Female is 2.67% and for Male 1.10%). This indicates a positive progress in overall nutritional status of the rural population. Alongside this trend, there is observed a decrease in underweight men and women but also an increase in overweight population across a ten year time period. The results also indicate that though the percentage of underweight follows a decreasing trend, it is less than the percentage of increasing overweight members implies the malnutrition still prevails across genders.

The regional differences across Maharashtra and Telangana states show improvements in BMI of women over time in both states with an overall growth rate of 2.35% and 3.59% respectively (Table-3). Compared to women, there is slower improvements in BMI among men in both the states with growth rate of 1.36% in Maharashtra region and 0.33% in Telangana region respectively. An interesting result is that the prevalence of overweight (with growth rate of 12.17% in Maharashtra and 9.73% in Telangana) is high among female members compared to male members across regions; at the same time reduction of underweight members are high among women compared to men across regions. This implies that one the one hand women show improvements in BMI from underweight to normal category but simultaneously there is movement of women from either underweight or normal category to overweight category. Thus the triple burden of malnutrition – under, over and also micronutrient malnutrition is clearly seen in the sample respondents in all the study villages.

Nutritional Status by Farm Group and Caste Group:

Across farm groups, the results are mixed. Women belonging to small farm size group made the most improvements in moving from the malnourished state to the normal category of BMI overtime with a growth rate of 3.19% followed by large, labor and medium farm groups (Table-4). However, the percentage of women who were overweight also increased more in the small farm size group (at the rate of 23% per annum). Large farm sizes made the greatest

reductions in underweight women. In summary, the analysis reveals that overweight women present among all the farm groups and it has increased overtime. Small farm group shows the highest increase of overweight female with the growth rate of 23% followed by labor farm group with about 14% growth rate respectively and this indication is quite rare and needs further understanding.

Table-5 presents the distribution of nutritional status among different caste groups overtime. Women with normal BMI and overweight members are highest among other backward class (OBC) with growth rate of 3.42% and 14.57% respectively. Women belonging to the forward caste had small improvements in their nutritional status but from the analysis it revelas that they has similar changes moving from underweight to normal category and normal to over weight category. The real improvements are noted in the schedule caste category – a two percent growth in normal BMI, reduction in underweight by 3.25 percent and no incidence of overweight women.

Nutritional Status by Socio-Economic Status

The relationship between the socio economic status and BMI among the female members of the households was analyzed and discussed in table 6. The households were divided into four groups using the highest and lowest income category. Reduction in percentage of women who were underweight was observed across all the income groups ranging between eight to four percent of compound growth rate. However, overweight incidences among the female members increased across all the income groups with highest percent (20%) in middle income group. Interestingly the women belonging to the poor income category has the highest improvements in normal BMI, had a 14.30 percent growth rate in overweight women and a decrease in underweight women by 6.77 percent annually. The women belonging to very high income category made the highest reductions in underweight women.

Household economic status is a key determinant of nutritional status of women. Evidence from the literature showed that compared with women residing in medium/higher economic status households, women in very poor or poor households have a significantly higher risk of being malnourished (Girma et al.,2002; Pryer et al.,2006). Similar findings were observed in earlier studies (Teller et al., 2015; UNICEF, 1990).This may be an indication that household economic status is positively associated with household food security, which is a prerequisite for access to adequate dietary intake and improved nutritional status for all members of the household.(Nguyen et al., 2013)

Conceptually, nutritional status (BMI) 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 (Viswanathan, 2015).

Table 7 presents the distribution of women's nutritional status among different expenditure groups. Results indicate double burden of malnutrition, with an increase in the overweight across all the expenditure groups ranging between seven to 11 percent growth rates. Reduction in the underweight was highest in the high expenditure followed by very high expenditure group with lowest reduction of 3 percent growth rate in the middle and low categories.

Interaction between Female BMI with Education, Lifestyle and Crop Diversity:

Level of education is a categorical variable for the women and is represented by five groups (i) illiterate (ii) primary, or (iii) secondary, or (iv) above secondary. The compound growth rate is calculated and compared with the mean BMI as nutritional status 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. Reduction of 14 percent in underweight category of women who had primary education (Table 8) followed by above secondary (7.24), secondary (5.73%), and illiterate (4.20%). The educated women above secondary category form a very small proportion of the women, thereby resulting in negligible growth rate under the overweight category. Similar comparable findings were suggested by several authors who noted that educated women assign a significantly larger proportion of their household food budget to food groups that are nutritionally rich in micronutrients (Smith and Haddad, 2000; Smith et al., 2003; Block, 2003), mainly because of greater awareness and understanding of nutritional health benefits (Smith, 2004). Increase in overweight category increased with the level of education with lowest (9.80 percent) in the illiterate category followed by primary (11.38) and secondary category (12.27). This could be that educated women maybe be now involved in more sedentary activities and hence there may be less energy expenditure by them leading to overweight.

Based on the life style index or Standard of Living (SOL), the table 9 represents the distribution of the nutritional status of women in relation to their standard of living. The data was analyzed on the premise that higher the standard of living better will be the nutritional status ie., BMI would be normal. This is indicated in the results with highest reduction in underweight (6%) in the high SOL category followed by medium (5%) and low (3.5%) SOL categories respectively. Increase in overweight category was high (15%) in medium SOL category followed by low (8%) and high (6%) SOL categories. Women in the low SOL category are largely affected by the double burden of nutrition with low reduction of underweight and increased growth rates in the overweight category. Similar results were found in the studies conducted in Kerala state of India by Ramesh, 2006.

The crop diversity index (CDI) categorized the households into low (CDI<0.25), medium (CDI between the 0.25 to 0.49) and high (CDI≥0.50) diversity. Table 10 presents the

distribution of of rural women in terms of their nutrition status in relation to the crop diversity indices. The results reveal reduction in the underweight (5-7%) and almost twofold increase in the overweight (12-14%) across all the categories. This indicates the internal shift from under nutrition to over nutrition, signifying the overall rise in malnutrition over a decade. The women with normal BMI increased about two to three percent across all the categories.

Determinants of Women's Nutritional Status: A Multivariate Analysis:

The descriptive analysis discussed in the earlier sections revealed that there were differentials in the malnutrition by socioeconomic, demographic and other variables. Also it is to be mentioned that some of these variables are interrelated. Therefore it is essential to assess the effect of an individual factor when other variables are controlled. Furthermore many factors related to malnutrition are also associated with each other. Therefore, when measuring the effects of any one factor on malnutrition, a multivariate analysis is necessary to control for the effects of other potentially confounding factors. In this regard a panel data logistic regression analysis is carried out to quantify the net effects of these background factors on each of the dependent variable.

Table 11 represents the results of the multivariate analysis of both underweight and overweight women in relation to socioeconomic, demographic characteristics, human capital, crop diversity and life-style indicators. Model-1 represent the results of the logistic regression model comparing underweight (BMI, <18.5 kg/m2) women with those of normal weight (BMI, 18.50-24.99). The analysis from this model revealed that caste and living standard have significant impact on a member to become underweight. Women belongs to OBC (coefficient=1.7351) and SC (coefficient=1.3119) category have significantly more probability of being underweight compare to forward caste women. Also women with low and medium lifestyle are more likely being underweight compared to women having a high standard of living. On the other hand variables such as education and income have significant role to reduce the burden of underweight in the study regions. Married women and women belongs to age group 35 to 50 years are significantly less likely to be underweight when compared with their respective base categories. It is found that household crop diversity have no significant impact in respect to a women being underweight or not. The logistic regression on overweight women (BMI 25 kg/m2) with those of normal weight (BMI, 18.50-24.99) is represented in model-2. The regression coefficient of per-capita income and women in age group 25 to 34 years and age group 35 to 50 years shows a significant positive value, indicating that income increases tend to make women over weight. Similarly women belonging to age group 25-50 years have a tendency to become overweight compared to women below 25 years of age and over 50 years of age. Crop diversity (coefficient= -1.1439) shows to have significant impact in reducing overweight among women. This implies that crop diversification may lead to diversity in diets and thus better diet quality. Women belonging to labor farm group and small farm group are significantly less likely to be overweight compared to women from large farm group. Women belonging to households with low and medium standard of living shows less probability to

being overweight compared to base category of high lifestyle. The results in table 11 do not give any significant relationship between education of women and their nutritional status.

Conclusion

The paper attempts to understand the role of human capital, crop diversity and other socioeconomic factors on the women's nutritional status in the semi-arid tropics of India.

Descriptive analysis revealed that though under nutrition is reducing, over nutrition is found to be increasing across all aspects such as across region, human capital (education), income categories, consumption expenditure categories, crop diversity categories, etc. resulting in the increase in the rates of overall malnutrition. Adequate nutrition is important for women not only because it helps them be productive members of society but also because of the direct effect maternal nutrition has on the health and development of the next generation. There is also increasing concern about the possibility that maternal malnutrition may contribute to the growing burden of cardiovascular and other non communicable diseases of adults in less developed countries. Finally, maternal malnutrition's toll on maternal and infant survival stands in the way of countries' work toward key global development goals (Elizabeth and Leslie, 2003).

Panel data logistic regression analysis considering underweight and overweight to normal BMI, it is found that married women and women belonging to ages more than 34 years are less likely to be underweight compared to unmarried and young women. Similar observation were drawn with women members with higher per-capita income. Likewise, the results also show that women between the ages 25 and above and with higher per capita income are also likely to be overweight. Households with low and medium standard of living are likely to have less overweight women compared to households with high standard of living.

As indicated in Lisa et al, 2003, the sustainable improvement of the nutritional status of children, women's status should be improved in all regions. Doing so is especially urgent for South Asia, followed by Sub Saharan Africa. Accomplishing this task requires policies that eradicate gender discrimination and policies that reduce power inequalities between women and men by proactively promoting catch-up for women. Examples include enabling women to gain access to new resources, implementing cash transfer programs that promote girls' education and health care, introducing technologies that save household labor, subsidizing child care for working parents, and initiating programs to improve the nutritional status of adolescent girls and young women. In communities that resist shifts in the power balance between genders, policies can mitigate the negative effects of the imbalance, rather than addressing it directly. Targeting health services to communities where women's status is low is one example of this indirect approach (Lisa etal., 2003). Similar analysis of the nutrition situation of women and children in South Asia and program by Vir, 2016, findings emphasize the significance of reaching women during adolescence, pre-conception and pregnancy stage. Ensuring women enter pregnancy with adequate height and weight and free from being anemic is crucial. Combining nutrition-specific interventions with measures for empowerment of

women is essential. Improvement in dietary intake and health services of women, prevention of early age marriage and conception, completion of secondary education, enhancement in purchasing power of women, reduction of work drudgery and elimination of domestic violence deserve special attention.

The paper concludes that agricultural diversification affects women nutritional status. and However, the role of education of women on their nutritional status did not come out clearly. Additional research and inquiries on this subject will lead to a more clearer picture. The findings alert agricultural planners, researchers and development investors to package crop diversification and lifestyle interventions with targeted nutrition goals.

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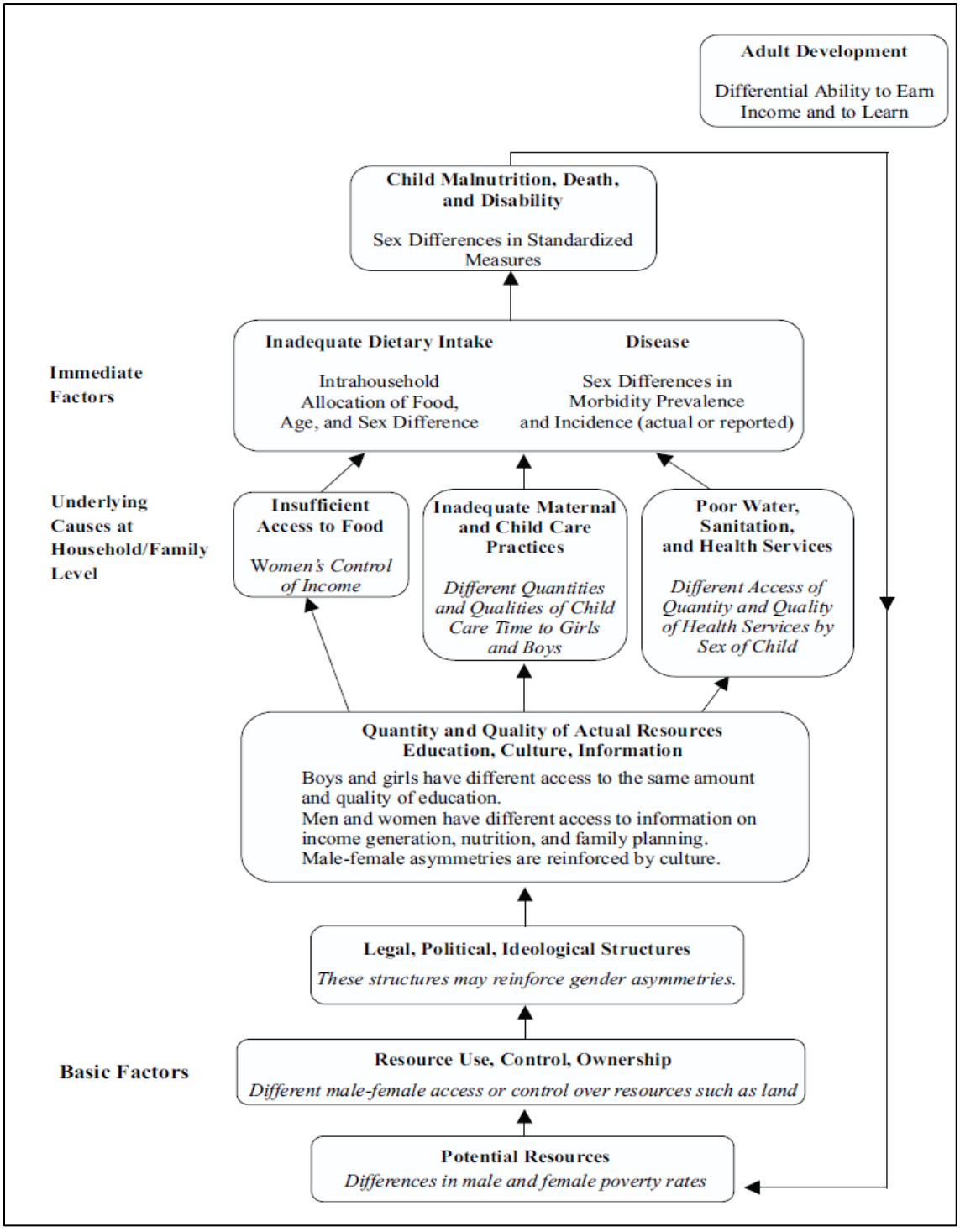

Figure 1 Gendered Conceptual Framework of the Determinants of Nutrition Outcomes
Source: Adapted from UNICEF, 1992

Table 1 Variables description used for multivariate analysis

Variables	Variables description
Dependent variables	Model-1: *women being underweight* (BMI <18.50 kg/m^2) compared with normal weight (BMI 18.5–24.9 kg/m^2) women. Model-2: *women being overweight or obese* (BMI 25.00 kg/m^2) compared with normal weight (BMI 18.5–24.9 kg/m^2) women.
Constant	Constant term
Members Educational level	It is measured in terms of level of literacy and the codes given are: 0 =illiterate, 1 = primary schooling, 2 = secondary and high school, 3 = graduate and above.
Per-capita income in current USD	Household per-capita income measures in current US dollar
Crop diversity index	An index measured with area 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
Region dummy	Region dummy describe Maharashtra region as 1 and Telangana region as 0
Labor farm group **Medium farm group** **Small farm group**	Farm group dummy: Large farm group considered as reference
Cast-OBC **Cast-SC**	Caste dummy: Forward caste is considered as reference group
Low standard of living **Medium standard of living**	Standard of living: measured by an index based on the housing and sanitation conditions and ownership of consumer durables including television and internet, which is used as a proxy for economic status. High standard of livening considered as reference
Age group dummy-1 (between age group 25 to 34 years) **Age group dummy-2 (between age group 35 to 50 years)**	Age group dummy: 15 to 24 years age group is considered as reference group
Marital status	A dummy variable and measure as, If the member is married considered as 1 and otherwise considered 0
Ratio of food to non-food expenditure	Ratio of food to non-food expenditure
Area cultivated (Ha)	Area cultivated by household in hectare

Source: Author's calculation based on ICRISAT VDSA dataset

Table 2 Overtime distribution of nutritional status across gender

Nutritional Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Female											
Normal BMI (%)	48	46	50	46	54	56	57	57	58	56	2.67
Over weight (%)	7	6	5	4	7	10	10	11	12	14	11.48
Under weight (%)	45	48	45	50	39	34	33	32	30	30	-5.93
Total Sample (N)	393	396	393	399	360	399	409	394	382	390	NA
Male											
Normal BMI (%)	52	50	51	49	60	57	57	56	56	54	1.10
Over weight (%)	9	8	8	7	6	9	10	10	10	11	4.36
Under weight (%)	39	42	41	45	33	34	33	34	34	35	-2.52
Total Sample (N)	392	399	412	414	338	425	451	413	430	438	NA

Source: Author's calculation based on ICRISAT VDSA dataset

Table 3 Overtime distribution of BMI among sample members across regions: 2005-2014

Regions	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
						Female						
Maharashtra region	Normal BMI (%)	48	47	50	46	54	56	55	56	57	55	2.35
	Over weight (%)	7	6	6	5	8	12	12	13	13	16	12.17
	Under weight (%)	45	47	44	49	38	32	33	31	30	29	-5.96
Telangana region	Normal BMI (%)	47	45	50	47	56	56	63	59	60	59	3.59
	Over weight (%)	8	5	4	1	1	4	5	5	9	10	9.73
	Under weight (%)	45	50	47	52	43	39	32	36	30	31	-5.80
						Male						
Maharashtra region	Normal BMI (%)	52	49	50	47	60	58	57	57	56	53	1.36
	Over weight (%)	8	8	7	7	7	10	11	10	11	12	5.79
	Under weight (%)	40	43	42	46	34	33	32	33	33	34	-3.24
Telangana region	Normal BMI (%)	52	55	54	52	63	56	57	52	56	55	0.33
	Over weight (%)	10	6	10	6	5	8	8	9	7	9	0.38
	Under weight (%)	38	39	36	42	32	36	35	39	37	37	-0.42

Source: Author's calculation based on ICRISAT VDSA dataset

Table 4 Farm group wise distribution of BMI among adult female members

Farm group	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Large	Normal BMI (%)	46	51	55	51	60	63	70	62	62	57	3.05
	Over weight (%)	11	5	8	6	11	12	11	12	15	17	10.03
	Under weight (%)	43	44	37	43	29	25	19	26	23	25	-7.91
Medium	Normal BMI (%)	46	45	47	41	53	46	46	51	52	53	1.75
	Over weight (%)	11	13	10	9	10	15	15	16	14	18	5.45
	Under weight (%)	43	43	43	50	37	40	39	33	35	29	-4.00
Small	Normal BMI (%)	50	42	51	43	54	58	57	57	60	57	3.19
	Over weight (%)	5	3	1	1	3	7	9	9	10	12	23.00
	Under weight (%)	45	55	48	56	43	35	35	35	29	31	-6.52
Labor	Normal BMI (%)	47	53	46	56	50	60	61	60	59	56	2.52
	Over weight (%)	3	4	4	3	6	5	4	8	10	12	13.73
	Under weight (%)	50	43	50	42	44	34	36	32	31	33	-5.25

Source: Author's calculation based on ICRISAT VDSA dataset

Table 5 Caste group wise distribution of BMI among adult female members

Caste	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Forward caste	Normal BMI (%)	53	55	59	55	63	62	63	60	64	64	1.95
	Over weight (%)	13	9	10	8	12	17	17	19	19	20	8.91
	Under weight (%)	34	36	30	37	25	20	20	21	17	17	-8.89
OBC	Normal BMI (%)	44	41	44	40	51	53	54	55	56	51	3.42
	Over weight (%)	5	4	3	2	4	7	7	8	8	12	14.57
	Under weight (%)	51	55	53	58	44	41	40	37	36	36	-5.31
SC	Normal BMI (%)	50	49	44	47	41	55	58	53	52	56	2.03
	Over weight (%)	0	3	0	0	0	3	3	0	10	6	-
	Under weight (%)	50	49	56	53	59	43	39	47	39	38	-3.75

Source: Author's calculation based on ICRISAT VDSA dataset

Table 6 Income group wise distribution of BMI among adult female members

Income group	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Poor	Normal BMI (%)	46	41	48	50	52	54	57	66	60	59	4.27
	Over weight (%)	4	5	1	2	3	4	7	4	9	10	14.30
	Under weight (%)	50	54	51	48	44	43	36	30	31	31	-6.77
Middle income	Normal BMI (%)	53	46	48	38	52	52	51	58	57	53	2.09
	Over weight (%)	1	2	5	2	1	6	7	7	7	7	20.56
	Under weight (%)	45	53	47	59	47	41	42	35	36	40	-3.92
High income	Normal BMI (%)	51	53	50	46	53	64	61	51	57	58	1.74
	Over weight (%)	11	8	5	4	10	8	8	8	14	13	6.41
	Under weight (%)	38	40	46	50	37	28	31	41	29	29	-4.05
Very high income	Normal BMI (%)	38	49	54	54	61	55	59	58	59	52	2.86
	Over weight (%)	29	11	10	10	13	18	16	18	21	32	6.19
	Under weight (%)	32	40	36	36	26	26	25	24	20	16	-8.35

Source: Author's calculation based on ICRISAT VDSA dataset

Table 7 Expenditure group wise distribution of BMI among adult female members

Expenditure group	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Low	Normal BMI (%)	46	46	39	38	44	62	59	30	52	51	1.36
	Over weight (%)	5	6	4	2	0	3	0	15	8	11	9.26
	Under weight (%)	50	48	57	60	56	34	41	55	40	38	-3.26
Middle	Normal BMI (%)	51	47	51	47	52	50	53	55	55	56	1.65
	Over weight (%)	6	5	3	2	5	5	7	3	8	10	7.12
	Under weight (%)	44	48	46	51	43	44	40	42	37	34	-3.03
High	Normal BMI (%)	46	42	48	45	55	67	55	58	61	58	3.93
	Over weight (%)	10	8	6	7	5	10	14	10	18	19	11.41
	Under weight (%)	44	50	47	48	40	22	32	31	21	23	-9.00
Very high	Normal BMI (%)	42	52	55	51	64	54	62	62	61	56	2.97
	Over weight (%)	23	3	9	8	15	18	11	19	12	23	9.16
	Under weight (%)	35	45	36	41	21	28	26	18	28	21	-7.31

Source: Author's calculation based on ICRISAT VDSA dataset

Table 8 Overtime distribution of adult female members BMI based on adult female members education level: 2005-2014

Education level	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Illiterate	Normal BMI (%)	49	47	52	50	57	57	57	57	55	50	1.34
	Over weight (%)	9	6	6	4	6	9	8	8	14	17	9.80
	Under weight (%)	42	47	42	46	37	34	35	35	31	33	-4.20
Primary	Normal BMI (%)	50	50	52	45	63	75	71	66	67	70	4.87
	Over weight (%)	11	6	6	5	5	7	11	13	16	20	11.38
	Under weight (%)	39	44	42	50	32	18	18	21	16	11	-14.32
Secondary	Normal BMI (%)	48	46	51	49	55	55	58	56	59	54	2.35
	Over weight (%)	6	6	6	5	6	12	12	12	12	14	12.27
	Under weight (%)	47	48	43	46	38	32	30	32	30	32	-5.73
Above Secondary	Normal BMI (%)	37	41	38	33	38	42	47	51	55	58	5.44
	Over weight (%)	0	0	0	0	10	8	8	10	8	8	-
	Under weight (%)	63	59	62	67	52	50	45	39	38	33	-7.24

Source: Author's calculation based on ICRISAT VDSA dataset

Table 9 Overtime distribution of adult female members BMI based on household standard of living: 2005-2014

Lifestyle category	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Low	Normal BMI (%)	50	46	51	46	53	51	56	59	57	48	1.53
	Over weight (%)	6	5	4	3	4	7	5	4	14	9	8.34
	Under weight (%)	44	49	45	51	43	42	39	37	29	42	-3.51
Medium	Normal BMI (%)	46	44	44	50	54	57	56	55	52	60	3.11
	Over weight (%)	4	5	1	3	2	7	6	6	8	10	15.10
	Under weight (%)	49	51	55	48	44	36	38	39	40	30	-5.21
High	Normal BMI (%)	43	49	53	44	56	57	58	57	59	56	3.04
	Over weight (%)	13	7	9	6	10	12	13	13	13	16	6.03
	Under weight (%)	44	44	38	49	34	31	30	30	28	28	-5.89

Source: Author's calculation based on ICRISAT VDSA dataset

Table 10 Crop diversity index wise distribution of adult female members BMI: 2005-2014

Diversity index category	BMI Status	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CGR (%)
Low diversity	Normal BMI (%)	54	48	48	46	55	57	58	56	59	59	2.30
	Over weight (%)	5	5	5	3	4	8	8	8	10	13	12.47
	Under weight (%)	41	47	46	51	40	35	34	36	31	28	-5.38
Medium diversity	Normal BMI (%)	46	53	57	40	48	58	64	60	65	56	3.07
	Over weight (%)	7	5	2	8	5	8	11	10	11	14	13.59
	Under weight (%)	46	42	41	52	47	33	25	30	24	30	-7.00
High diversity	Normal BMI (%)	44	43	49	49	57	55	53	56	53	51	2.16
	Over weight (%)	9	6	6	4	9	12	11	15	15	17	12.59
	Under weight (%)	47	51	44	47	34	33	35	30	33	32	-5.56

Source: Author's calculation based on ICRISAT VDSA dataset

Table 11 Women being Underweight and Women being Overweight compared to Normal BMI: A dynasty panel logistic regression

Variables	Coefficients	
	Underweight Vs Normal BMI	Overweight Vs Normal BMI
Constant	1.3503*	-8.0110***
Members Educational level	-0.4553*	-0.3433
Per-capita income in current USD	-0.0011***	0.0005***
Crop diversity index	0.4989	-1.1439**
Region dummy	0.1544	1.4990*
Labor farm group	-0.0234	-2.7436***
Medium farm group	-0.0457	0.4452
Small farm group	-0.6575	-1.3215*
Cast-OBC	1.7351***	-0.4595
Cast-SC	1.3119*	-0.5032
Low standard of living	1.1297***	-2.3566***
Medium standard of living	1.0764***	-1.7651***
Age group dummy-1 (between age group 25 to 34 years)	-0.1573	1.6727**
Age group dummy-2 (between age group 35 to 50 years)	-1.3482***	4.2684***
Marital status	-3.1852***	0.0185
Ratio of food to non-food expenditure	-0.0468	0.1950
Area cultivated (Ha)	0.0263	-0.0312
Log likelihood	1420.70	537.60
Wald chi^2	173.61	91.21
Prob > chi^2	0.00	0.00
Number of observations	3576	2406

Source: Author's calculation based on ICRISAT VDSA dataset

*** p<0.01, ** p<0.05, * p<0.1