

Food and Nutritional Security through Nutrition-Sensitive Interventions in the Hills of Uttarakhand, India

Renu Jethi¹, Pankaj Nautiyal², Asmita Jalal³, Kailash Singh⁴, Manisha Arya⁵,
Pratibha Joshi⁶ and Nirmal Chandra⁷

^{1,3,7}ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan Almora 263 601,
Uttarakhand, India

¹E-mail: renujethi2009@gmail.com

^{2,4,5}KVK, Chinyalisaur, Uttarkashi, Uttarakhand, India

⁶ICAR-Indian Agricultural Research Institute, New Delhi, India

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ABSTRACT This paper deals with the investigation of existing malnutrition among women of the hill region of Uttarakhand (a mountain state in India that comes under the northwest Himalayan region) and nutrition related interventions to address it. The existing level of malnutrition among women in high hills was evaluated using Body Mass Index and the prevalence of chronic energy deficiency was found to be 36.5 percent. Minimum Dietary Diversity for Women of reproductive age (MDD-W) was calculated before and after the implementation of interventions with the same set of respondents. Overall impact of nutrition related interventions shows that the MDD-W score for women reached from 3.9 to 5.5 after interventions. As a result of interventions more than ninety percent of women achieved minimum dietary diversity with adequate micronutrient intake. Specifically designed agriculture-based interventions with focus on nutrition have resulted in a more diversified and nutritive dietary pattern among the target group in the hill region of Uttarakhand.

INTRODUCTION

Globalisation has been playing an important role in the development of dietary patterns linked with nutrition transition and growth of diet-related chronic diseases in developing countries like India. Changes in food demand and food supply have adversely affected these dietary patterns among urban and rural areas of developing nations.

Many studies have emphasised that increasing food production alone cannot address the issues related to malnutrition until and unless the poorest and vulnerable group has access to diversified and nutritious food. Food security encompasses 'availability', 'accessibility' and 'utilisation', which include 'absorption' and bioavailability of food, making it inclusive of 'nutrition security'. Therefore, agriculture-based interventions in the present scenario need to be more nutrition-sensitive, with a greater focus on nutrient-dense food. In the hill region of Uttarakhand, a large population depends on agriculture and animal husbandry for livelihood and food security. The problem of malnutrition can be better addressed through nutrition sensitive agriculture-based interventions specifically designed for women, as they form the active workforce in hill farming.

Uttarakhand is basically an agricultural state, but its share in the country's total area

and production is very small. Although seventy-five to eighty-five percent of the population is dependent on agriculture, it contributes to only 23.4 percent in state domestic product (Uttarakhand at a Glance 2016-17). Moreover, production and productivity of various major crops is very low in hills (Anonymous 2017). As a result, many households in the hill region face food and nutritional insecurity. Urban growth and changes in land use pattern has led to depletion and destruction of natural resources. In the hill region, the majority of farmers are practicing traditional subsistence farming, which cannot sustain the farm households for more than three to four months in a year. Therefore, one or more family members are migrating to urban places within and outside the state in search of jobs. Various studies revealed that the low agricultural productivity and subdivision of landholdings due to increase in family size are among the major factors motivating migrations from the hills (Jain 2010; Grunawalt 2012; Anonymous 2018). 'Too much or too little water' has significantly added to the vulnerability of hill agriculture, which is mainly rainfed. Mountain regions are experiencing frequent flash floods along with longer periods of droughts, resulting in low crop productivity and a higher prevalence of food insecurity (Hussain et al. 2016). In

Uttarakhand 74.4 percent of the population lives in villages, out of which 50.2 percent are women. The gender ratio in the hills is 1,064 whereas in the plains it is 905. There remains an over representation of women in rural areas of the hills. Here, women are the active workforce due to their increased involvement with agriculture, animal husbandry, fodder and fuel-wood collection and other household related activities. In the state, 43.75 percent of families are below the poverty line (Uttarakhand at a Glance 2016-17). Although women everywhere work for longer hours, the plight of poor rural women in the hills is rather worse. Women are mostly involved in drudgery prone agricultural and household activities that require more time and energy. These strenuous physical activities combined with limited food and nutrient intake, aggravate malnutrition among women. Malnourished women are prone to infection and hence the rate of morbidity and mortality also increases. People of these areas highly depend on a starch rich diet, which is deficient in many key micronutrients. Consumption of diet deficient in nutrients leads to nutrient deficiencies among women and children, a vulnerable group in the hill community. Vitamin A and iron deficiency is more prevalent among the women population of the area. Women's education, social status, health and nutritional status and their control over resources are among the major factors contributing to overall nutritional outcomes. As per the NFHS 2018, forty-two percent of women in Uttarakhand have anaemia including thirty-one percent with mild anaemia (10.0-10.9 g/dl), ten percent with moderate anaemia (7.0-9.9 g/dl) and one percent with severe anaemia (<7.0 g/dl). Low nutritional status makes women more prone to certain ailments. Some studies showed that the majority of rural women in Uttarakhand were suffering from the various degrees of chronic energy deficiency (Kukreti et al. 2013; Pant 2016). Studies also reported low intake of micronutrients by women in the hills of Uttarakhand, which is lower than the Recommended Dietary Allowance (Upadhyay et al. 2011; Jethi et al. 2018). It was also reported in NFHS-4 that in Uttarakhand only 56.3 percent, 44.1 percent and 17.6 percent women were consuming pulses, vegetables and fruits daily respectively, which are good sources of

micronutrients. As a result of changing food systems, the rural population on hills are also relying on purchased and processed food. These changes have increased overweight cases, and cases of diet related chronic diseases such as diabetes. The National Family Health Survey-4 (NFHS-4, 2018) also reported that under-nutrition among women (indicated by Body Mass Index of less than 18.5 kg/m²) reduced from thirty to eighteen percent between 2005-2006 and 2015-2016. However, this period also witnessed a rise in the proportion of overweight or obese women, as their share in the population was twenty percent in 2015-2016. Various evidence on what actually works to improve nutrition points to the role of important drivers, such as improvements in household assets, food security, women's status, sanitation, and provision of healthcare, in addition to targeted nutrition interventions. Yet, because malnutrition (including over nutrition) is complex and driven by several determinants at multiple levels, it cannot be addressed with single-shot interventions (Kimberly 2016; Kohli et al. 2017).

A number of reviews show evidence that agricultural development programmes that promote production diversity, micronutrient rich crops (including biofortified crops), and dairy or animal husbandry can improve dietary diversity at the household level (Berti et al. 2004; Masset et al. 2012; Webb-Girard et al. 2012; Webb and Kennedy 2014; Fiorella et al. 2016; Pandey et al. 2016). Ensuring food security has become a big challenge in the hills, as farmers are already facing the constraints of fragmented landholdings, difficult terrain, unfavourable biophysical conditions, low crop productivity, physical isolation and limited market access (Rasul et al. 2014). In the hill region of Uttarakhand, climatic conditions are very much favourable for growing many diversified crops around the year. The increase in food production and productivity may not necessarily lead to improvements in diet or nutrition. Even if agriculture production or productivity increases, the consumption pattern of people may stay the same in absence of social and behavioural changes.

Nutrition Based Project

One of the solutions to this prevailing problem of nutrition transition in Uttarakhand

hills can be “local needs met locally”. Local nutritional needs can be met locally by reviving traditional practices along with amalgamation of science and technology knowledge. Various studies generated evidences of effective models of connecting agriculture with the nutritional outcomes, which could be used to frame gender-and-nutrition-sensitive farming systems in different agro-ecological zones of the country and the region (Das et al. 2014).

Therefore, a project was designed under the National Mission for Himalayan Studies to improve nutritional level of women in high hills of Uttarakhand through nutrition sensitive agriculture interventions. A nutrition sensitive approach was promoted at the local level with active participation of women who are mainly responsible for food security of households. This work was initiated in 2018 in high hills of two districts in Uttarakhand. Baseline survey was conducted to know the ground realities of food production system, food consumption pattern in the selected area. Transect walk of the entire area and focus group discussion led to the selection of nutrition sensitive agriculture interventions. Project staffs were trained on data collection, selection and implementation of project interventions. The hypothesis underlying the project is that specifically designed agricultural interventions for the hill region with focus on nutrition can result in a more diversified and nutritive dietary pattern along with enhanced agricultural productivity.

Objective of the Study

1. To investigate nutritional status and dietary diversity among farmwomen in selected production systems of high hill regions.
2. To assess the impact of nutrition related interventions on dietary diversity of farmwomen in high hill regions.

METHODOLOGY

The study was conducted from May 2018 to July 2019 in two hill districts of Uttarakhand, India. The two project sites selected were mainly agriculture based (Table 1). Families were engaged in subsistence farming of cereals and millets.

Table 1: Project sites selected under the project

High altitude villages of Pithoragarh district.	Elevation: 5864 ft (1787 m) amsl
Baitholi	29° 49' 23.18" N
Kiroli	80° 02' 42.75" E
High altitude villages of Uttarkashi districts	Elevation: 7382 ft (2250 m) amsl 6302 ft (1921 m) amsl
Raithal	30° 52' 74.69" N
Jogath	78° 43' 53.30" E

The study design was cross-sectional, with farmwomen being study units. Baseline data was collected from 175 women through a structured questionnaire, which covered the broad range of aspects with regards to socio-economic condition, cropping pattern, food consumption pattern and constraints in farming. Data collected under this study may not be a true representative of the whole hill region, as districts were selected purposively in view of their higher vulnerability due to low agriculture productivity and remoteness.

Based on the results of baseline data, some nutrition-sensitive agriculture interventions were implemented in the region.

Under the project, nutrition-sensitive agriculture interventions were implemented in three main areas.

1. Enhancement in the food productivity to make enough food available and accessible at local level. In order to address the prevailing issue of low productivity in the hills, high yielding varieties of wheat, finger millet and lentil (major crops of the hill region) were introduced in the project area along with the recommended package of practices.
2. Enhancement in food diversity through production of diverse crops. Diverse crops were promoted through family farming, nutri-gardens for production of vegetables and fruits, mushroom, honey, micro-greens, etc. at local levels.
3. Making food itself more nutritious. This included production and incorporation of fortified crop varieties in the diet to improve nutritional status. Local cultivars of maize used by women were replaced by Vivek QPM 9, which is a quality protein maize variety.

A total 63 women were selected for implementation of nutrition sensitive interventions. The subjects selected were in the age group of 15 to 50

years (excluding pregnant and lactating women) and actively engaged in farming. Those women who willingly cooperated to provide the information required for the study were only included in the study.

For assessment of nutritional status, Body Mass Index of women was recorded using weight and height of the respondents. The method suggested by Gibson 1990 was followed for this study.

$$\text{BMI (kg/m}^2\text{)} = \frac{\text{Weight (kg)}}{\text{Height (m)} \times \text{Height (m)}}$$

The respondents were categorised into different grades of nutritional status using BMI index (James et al. 1988).

<i>BMI grades</i>	<i>BMI range</i>
CED III	Less than 16
CED II	From 16-17
CED I	From 17-18.5
Low-Normal	From 18.5 to 20
Normal	From 20-25
Overweight and obesity	More than 25

Dietary diversity is defined as the number of individual food items or food groups consumed over a given period of time (Ruel 2018). Minimum Dietary Diversity for Women of reproductive age (MDD-W) is a dichotomous indicator of whether or not women of 15-49 years of age have consumed at least five out of the ten defined food groups, the previous day or night. In the present study, dietary issues were investigated as counts of food groups consumed in the previous 24 hours. The ten MDD-W food groups were used as recommended by FAO, namely, grains, white roots and tubers and plantains, pulses, nuts, dairy, meat, poultry and fish, eggs, dark green vegetables, other vitamin A rich fruits and vegetables, other vegetables and other fruits. Food items that were consumed by women in quantity of more than 15 grams were considered under the food groups (FAO 2013). Therefore, the questionnaire recommended by FAO for MDD-W was adapted with some modification like replacing examples of food items by a list of common food in the local context. In order to assess the impact of nutrition related interventions on women the minimum dietary diversity score of women was calculated before and after the interventions using the questionnaire.

The problems and constraints faced by the hill farmwomen in agriculture production were worked out. The women were asked to rank the constraints perceived as limiting agriculture production in the order of preferences. Based on responses obtained from 63 selected respondents, the Rank Based Quotient (RBQ) for each constraint was calculated.

$$\text{Rank Based Quotient} = \frac{\sum fi (n + 1 - i)}{N \times n} \times 100$$

Where, f_i = frequency of farmers for i^{th} rank of the constraints, N = number of farmers, n = number of constraints identified and i = concerned ranks.

RESULTS AND DISCUSSION

Socio-economic Status

Table 2 reveals that majority of the women (46%) were illiterate, belonged to nuclear families (80%), with main occupation agriculture (74%). Dhanaraj and Mahambare (2017) reported a decline in the number of rural women living in joint families from forty-three to thirty-four percent between 2005 and 2012 in India. The majority of the surveyed population belong to Other Backward Class (63%) and were below poverty line (89%). Yadav (2013) also reported in a study that 41.6 percent hill farmwomen

Table 2: Socio-economic and demographic characteristics of women farmers

<i>S. No.</i>	<i>Particulars</i>	<i>Category</i>	<i>Percentage</i>
1	Education	Illiterate	46
		Primary	20
		Secondary	17
		High School	7
		Intermediate	8
2	Occupation	Graduate and Above	2
		Agriculture	74
		Government Service	9
4	Family Type	Others	17
		Nuclear	80
		Joint	20
5	Caste Composition	General	32
		OBC	63
		SC/ST	5
6	Income Group	Below Poverty Line	89
		Above Poverty Line	11
7	Average Size of Landholdings		0.2 hectares
8	Average Age of Women at Marriage		20

were engaged in agriculture only and majority belonged to other backward class. Women in rural areas being mostly illiterate or with the low level of education have inhibitions in working as manual labour in the non-agriculture sector. They have a preference for women-centric work, which can be done within the periphery of the household (Sanghi et al. 2015). Nutri-gardening can be done efficiently by women, as it can easily blend with their domestic duties.

Nutritional Status of Women

The extent of malnutrition in women was assessed by computing the BMI (Body Mass Index). On the basis of Body Mass Index, different grades of Chronic Energy Deficiency were evaluated. The overall prevalence of malnutrition was depicted as different grades of CED along with low to normal BMI was 36.5 percent (Table 3). The mean BMI (\pm SD) of the women was 21.9 (\pm 3.1) kg/m². Similar results were reported by Jose and Navaneetham (2008) and Pant (2016). Therefore, investments in improving nutritional status of women are very important. The data shows that 15.9 percent women were overweight or obese, which poses a challenge of non-communicable diseases. Nutritional inadequacy is one of the most important factors for many non-communicable diseases in Uttarakhand (Thapliyal and Singh 2014).

Dietary Diversity Score (DDS)

In the present study, sixty-three selected women were encouraged to produce seasonal vegetables in nutri-gardens along with mushroom production, bee keeping and micro-greens. Regular trainings and exposure visits were conducted on the improved package of practices for vegetable production along with field monitoring for controlling insect-pest infestations. Women were linked to a need-based SMS service for receiving messages related to insect-pest infestation, improved agronomic practices, improved crop varieties and health and nutrition issues.

Minimum Dietary Diversity for Women of reproductive age (MDD-W) was calculated before the implementation of the interventions and after interventions with the same set of respondents. Women had a very low dietary diversity score (3.9) with standard deviation of 0.9,

Table 3: Categorization of grades of nutritional status using BMI index

BMI grades	BMI range	Percentage
CED III	Less than 16	1.6
CED II	From 16-17	1.6
CED I	From 17-18.5	20.6
Low-Normal	From 18.5 to 20	12.7
Normal	From 20-25	47.6
Overweight and obesity	More than 25	15.9

as 69.8 percent were found to be consuming less than five food groups in their diet. Gitagia et al. (2019) also reported DDS of 3.78 \pm 0.99 among women of reproductive age. After the implementation of nutrition sensitive agricultural intervention, the MDD-W score reached 5.5 with a standard deviation of 0.8. More than ninety percent of women achieved minimum dietary diversity and they are more likely to have higher (more adequate) micronutrient intake (Table 4). Similar results were reported by Shashikantha et al. (2016) and Singh et al. (2020). To address the issues of nutritional deficiencies among women, Helen Keller International implemented homestead food production programs in various developing nations through various interventions like home gardening, and animal husbandry along with nutrition education, which resulted in significant improvement in dietary diversification and food security (Talukder et al. 2010).

It is also very important to present the average number of fruit and vegetable groups consumed out of the four groups ("dark green leafy vegetables", "other vitamin A-rich fruits and vegetables", "other fruits" and "other vegetables"). Before intervention, the consumption of the number of fruit and vegetable groups was 1.5 with a standard deviation of 0.87, whereas after intervention it increased to 2.5 with a standard deviation of 0.76 among women of high hills (Fig. 1). There was found to be a significant difference at 0.05 level of probability in consumption of number of fruit

Table 4: Minimum dietary diversity score before and after nutrition-sensitive agriculture interventions

Range of minimum dietary diversity score	Before intervention	After intervention	Difference
Less than 5	69.8	7.9	Z value =
% and above 5	30.2	92.1	9.3*
Mean and SD	3.9 \pm 0.9	5.5 \pm 0.8	P value =
			<0.0001

*significant at 0.05 probability level

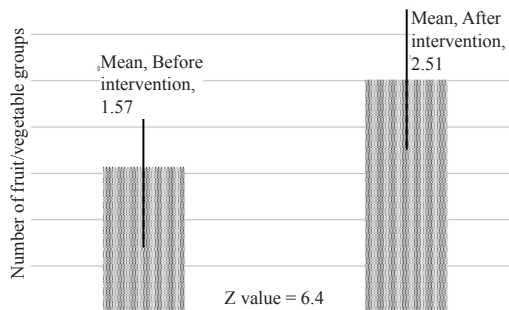


Fig. 1. Mean (SD) number of fruit/vegetable groups consumed before and after interventions

and vegetable groups after the implementation of interventions.

Dietary Consumption Pattern

In order to know the impact of nutrition-sensitive agriculture interventions, the food consumption pattern of selected 63 women was examined before and after the implementation of interventions. There was an increase in respondents consuming diversified food groups in their daily diet after interventions. Cereals (including millets) were the staple food consumed daily by the women in order to meet daily requirements of calories. In a study related to household food security, the diet of the women who consumed only one food group basically consisted of starchy staple foods (Aubra et al. 2019). Only 50.8 percent women consumed pulses daily but after the intervention (high yielding varieties of pulse crop, health related awareness programmes) the percentage of women consuming pulses daily increased by forty-three percent. Bhandari et al. (2016) in a study related to the dietary intake pattern among women found that the majority of the women in mountains consumed pulses or legumes thrice a week. Women of the region were consuming other vegetables mostly on a weekly basis but after interventions like demonstrations of nutri-gardens, 76.2 percent women have started consuming it on the daily basis. Similarly, percentage of women consuming green leafy vegetables and milk and milk products daily has increased by fifteen percent and 55.2 percent, respectively (Table 5). Similar results were reported by Talukder et al. (2010).

Before the nutritional awareness programme and interventions, roots and tuber consumption was very high among women of hill region, which has now slightly decreased after interventions, as it has been balanced with other micronutrient rich food groups. Consumption of mushroom is also introduced in the project area among women, which was earlier an unknown food item for them. Women were trained in mushroom production and bee keeping techniques, and were encouraged to include it in their diet to meet protein requirement.

Constraint Analysis

Focus group discussions and personal interviews were conducted to find the prominence of constraints faced by women in agriculture production in the hill region (Table 6). Among many factors, animal menace (RBQ 98.1) is the most prominent constraint faced by women in the hill region followed by lack of irrigation facilities (RBQ 77.7), unavailability of improved seeds (RBQ 70.6), insect and pest infestation (RBQ 52.6), lack of manpower (RBQ 28.3) and lack of market opportunities (RBQ 22.2). Encroachments made by wild animals in the agriculture land and lack of irrigation facilities are the major problems in the hill region that have been revealed in some studies (Salgotra 2017). Pandey et al. (2019) also reported in a study that

Table 5: Food consumption pattern of women before and after implementation of nutrition sensitive agricultural interventions

Food groups		Daily (%)	Weekly (%)	Occasionally (%)	Never (%)
Cereals	BI	100	-	-	-
	AI	100	-	-	-
Pulses	BI	50.8	39.7	9.5	-
	AI	73	27	-	-
Root and Tubers	BI	95.2	4.8	-	-
	AI	84	16	-	-
Green Leafy Vegetables	BI	15.8	71.4	12.8	-
	AI	39.6	60.4	-	-
Other Vegetables	BI	-	23.8	76.2	-
	AI	76.2	23.8	-	-
Meat/Fish/Egg/Mushroom	BI	-	11	28.6	60.4
	AI	-	23	15	39.7
Milk and Milk Products	BI	28.6	36.5	19	15.9
	AI	44.4	28.6	14.3	12.7

BI-Before Interventions AI-After Interventions

Table 6: Constraints faced by women in agriculture production in hill region

S. No.	Constraints	RBQ	Rank
1	Animal menace	98.1	I
2	Lack of irrigation facilities	77.7	II
3	Unavailability of improved seeds	70.6	III
4	Insect-pest infestation	52.6	IV
5	Lack of manpower	28.3	V
6	Lack of market opportunities	22.2	VI

wild pigs emerged as a major menace followed by porcupines and mice that raid the cereal and vegetable crops. Similar results were also reported by Bhutia et al. (2017) and Bhartiya et al. (2017). In order to address the constraint of animal menace and insect and pests, fencing of home gardens along with installation of light traps was done with active participation of women.

CONCLUSION

The results show that dietary diversity was low among women in the hills. Agriculture based nutrition interventions had a positive impact on enhancing dietary diversity and food security by increasing round the year availability of diverse food. Homestead food production has the potential to increase micronutrient availability and improve the nutritional status of rural women in hills. The issue of increasing malnutrition among people and particularly women is not always due to poor living status or lack of sufficient food, but can be due to a lack of awareness about the right kind of diet required for the proper growth and functioning of the body. Therefore, creating awareness about nutrition and health is an important task especially in the rural areas of hills. The awareness campaign regarding proper nutrition, nutri-gardening and dietary habits needs to be demonstrated in the rural and remote areas. Nutri-gardening is one of the advantageous ways to improve nutrition levels in women with minimum investment. The geographical and climatic attributes in the hill region are highly suitable for the production of micronutrient rich fruits and vegetables. Micronutrient malnutrition can be overcome by including a variety of fruits and vegetables in the daily food basket. Increasing variability in diet is one of the important dietary strategies that can help in improving both situations of undernourishment and overweight. Nutrition interventions focusing on improving dietary diversity and dietary quality

should receive emphasis in developing region-specific interventions instead of generalised interventions.

RECOMMENDATIONS

Nutrition-related interventions implemented under the project proved to be effective in enhancing food production and diversify dietary intake. To replicate these interventions beyond the region, more systematic and location-specific integrated interventions are recommended. These should include production related and awareness creation activities to promote improved food production and consumption choices at the household and community levels. It is very important that these interventions are expanded to other areas as well where micronutrient deficiencies are a public health problem. There is an urgent need to reassess nutrition related agriculture and health policies. To promote nutrition sensitive agriculture, a systemic approach and cross-sector collaborations are needed.

LIMITATIONS

This study is limited to farmwomen engaged in subsistence farming in high hills of two districts of Uttarakhand.

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REFERENCES

- Aubra L, Savy M, Fortin S, Kameli Y, Kodjo NE, Fainke K, Mahamadou T, Port AL, Prevel YM 2019. The minimum dietary diversity for women of reproductive age (MDD-W) indicator is related to household food insecurity and farm production diversity: Evidence from Rural Mali. *Current Developments in Nutrition*, 3(3). <https://doi.org/10.1093/cdn/nzz002>.

- Anonymous 2017. *Agricultural Statistics of Uttarakhand 2014-15 & 2015-16*. Statistics Department, Directorate of Agriculture, Uttarakhand.
- Anonymous 2018. Human Development Report of the State of Uttarakhand, Directorate of Economics & Statistics, Department of Planning, Government of Uttarakhand. From <https://des.uk.gov.in/files/HDR_Report_Uttarakhand.pdf> (Retrieved on 11 September 2019).
- Berti PR, Krusevec J, FitzGerald S 2004. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutrition*, 7: 599–609.
- Bhandari S, Sayami JT, Thapa P, Sayami M, Kandel BP, Banjara MR 2016. Dietary intake pattern and nutritional status of women of reproductive age in Nepal: Findings from a health survey. *Archives of Public Health*, 74: 2. DOI 10.1186/s13690-016-0114-3
- Bhartiya A, Chandra N, Pal RS, Aditya JP, Bajeli J 2017. Comparative yield gaps, economic impact and constraint analysis in front line demonstrations of soybean and black soybean in Uttarakhand hills. *Indian Journal of Agricultural Research*, 51(5): 483-487.
- Bhutia TL, Kamal RK, Mohanty S, Kumar U 2017. Constraints in the crop-livestock farming systems of small and marginal farmers of Bihar. *SKUAST Journal of Research*, 19(1): 92-96.
- Das PK, Bhavani RV, Swaminathan MS 2014. A farming system model to leverage agriculture for nutritional outcomes. *Agric Res*. doi 10.1007/s40003-014-0119-5.
- Dhanaraj S, Mahambare V 2017. Family Structure, Education and Women's Employment in Rural India. *WIDER Working Paper 2017/195*. Helsinki: UNU-WIDER.
- FAO 2013. *Guidelines of Measuring Household and Individual Dietary Diversity*. Nutrition and Consumer Protection Division. Food and Agriculture Organization of the United Nations.
- Fiorella KJ, Chen RL, Milner EM, Fernald LCH 2016. Agricultural interventions for improved nutrition: A review of livelihood and environmental dimensions. *Global Food Security* 8: 39–47.
- Gibson RS 1990. *Principles of Nutritional Assessment*. Oxford: Oxford Publishing Company.
- Gitagia MW, Ramkat RC, Mituki DM, Termote C, Covic N, Cheserek MJ 2019. Determinants of dietary diversity among women of reproductive age in two different agro-ecological zones of Rongai Sub-County, Nakuru, Kenya. *Food and Nutrition Research*, 63: 1553. <http://dx.doi.org/10.29219/fnr.v63.1553>
- Grunawalt Peter 2012. Why are Cities the Only Place for Dreams? Outmigration of Youths From Rural Uttarakhand. Independent Study Project (ISP) Collection. 1297. From <https://digitalcollections.sit.edu/isp_collection/1297> (Retrieved on 11 February 2020).
- Hussain A, Agrawal NK, Leikanger I 2016. Action for adaptation: Bringing climate change science to policy makers - a synthesis report of a conference held in Islamabad on 23–25 July 2015. *Food Security*, 8(1): 285–289.
- Jain A 2010. *Labour Migration and Remittances in Uttarakhand*. Kathmandu: ICIMOD.
- James WPT, Lyzzi AF, Waterlow JC 1988. Definition of chronic energy deficiency in adults. *European Journal of Clinical Nutrition*, 42: 969-981.
- Jethi R, Joshi P, Chandra N, Roy ML, Joshi K 2018. Investigation of nutritional and health status of Indian rural hill farm women. *Journal of Community Mobilization and Sustainable Development*, 13(1): 169-176.
- Jose S, Navaneetham K 2008. A factsheet on women's malnutrition in India. *Economic and Political Weekly*, 61-67.
- Kimberly K 2016. Improving Nutrition in India: Taking Flight with Women Improving Nutrition through Group-based Strategies (WINGS). International Food Policy Research Institute. From <<http://www.ifpri.org/blog/improving-nutrition-india-taking-flight-wings>> (Retrieved on 11 February 2020).
- Kohli N, Nguyen PH, Avula R, Menon P 2017. Improving Nutrition in Uttarakhand: Insights from Examining Trends in Outcomes, Determinants and Interventions between 2006 and 2016. *POSHAN Policy Note 21*. New Delhi: International Food Policy Research Institute.
- Kukreti VT, Bisht AT 2013. Stress and nutritional status of individuals in Uttarakhand, Northern India: Differential effect of gender. *Health Promotion Perspectives*, 3(2): 255-260.
- Masset E, Haddad L, Cornelius A, Isaza-Castro J 2012. Effectiveness of agricultural interventions that aim to improve nutritional status of children: Systematic review. *BMJ*, 344: d8222–d8222. doi:10.1136/bmj.d8222.
- NFHS 2018. *National Family Health Survey-4*. International Institute for Population Sciences. Ministry of Health and Family Welfare. Government of India.
- Pandey L, Arunachalam A, Joshi N 2019. Challenges of hill farming due to crop raiding by wild pigs in the Indian Himalayan region. *Current Science*, 116(6): 1015-1019.
- Pandey VL, Dev SM, Jayachandran U 2016. Impact of agricultural interventions on the nutritional status in South Asia: A review. *Food Policy*, 62: 28–40.
- Pant BR 2016. Demographic profile and nutrition status of women in Uttarakhand. *ENVIS Bulletin Himalayan Ecology*, 24: 101-108.
- Rasul G, Hussain A, Khan MA, Ahmad F, Jasra AW 2014. Towards a Framework for Achieving Food Security in the Mountains of Pakistan. In: *ICIMOD Working Paper 2014/5*. Kathmandu: ICIMOD.
- Ruel MT, Quisumbing AR, Balagamwala M 2018. Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security*, 17: 128–153. <https://doi.org/10.1016/j.gfs.2018.01.002>
- Salgotra AK 2017. Problems and agriculture land holding pattern among BPL households in hill rural areas: A study of Pauri district of Uttarakhand. *International Journal of Humanities and Social Science Studies*, 4(1): 103-109.
- Sanghi S, Srijia A, Vijay SS 2015. Decline in rural female labour force participation in India: A relook into the causes. *The Journal for Decision Makers*, 40(3): 255-268.
- Shashikantha SK, Sheethal MP, Vishma BK 2016. Dietary diversity among women in the reproductive age group in a rural field practice area of a medical college in Mandya district, Karnataka, India. *International Journal of Community Medicine and Public Health*, 3(3): 746-749.
- Singh DR, Ghimire S, Upadhyay SR, Singh S, Ghimire U 2020. Food insecurity and dietary diversity among lactating mothers in the urban municipality in the mountains of Nepal. *PLoS One*, 15(1): e0227873. <https://doi.org/10.1371/journal.pone.0227873>
- Talukder A, Haselow NJ, Osei AK, Villate E, Reario D, Kroeun H, SokHang L, Uddin A, Dhungel S, Quinn V

2010. Homestead Food Production Model Contributes to Improved Household Food Security and Nutrition Status of Young Children and Women in Poor Populations - Lessons Learned from Scaling-up Programs in Asia (Bangladesh, Cambodia, Nepal and Philippines). Field Actions Science Report. From <<https://www.researchgate.net/publication/242663598>> (Retrieved on 15 February 2020).
- Thapliyal V, Singh K 2014. Nutrition transition: A paradigm shift in Uttarakhand. *Journal of Nutrition and Food Sciences*, 4(5): 1-5. doi: 10.4172/2155-9600.1000298
- Upadhyay SK, Raghuvanshi AR, Singh BB 2011. Nutritional status and knowledge of hill women on anemia: Effect of various socio-demographic factors. *Journal of Human Ecology*, 33(1): 29-34.
- Uttarakhand at a Glance 2016-17*. Directorate of Economics and Statistics. Department of Planning, Dehradun, Uttarakhand.
- Webb-Girard A, Cherobon A, Mbugua S, Kamau-Mbuthia E, Amin A, Sellen DW 2012. Food insecurity is associated with attitudes towards exclusive breastfeeding among women in urban Kenya. *Maternal & Child Nutrition*, 8: 199-214.
- Webb P, Kennedy E 2014. Impacts of agriculture on nutrition: Nature of the evidence and research gaps. *Food and Nutrition Bulletin*, 35: 126-132.
- Yadav N 2013. Social status of women engaged in sericulture enterprise in Uttarakhand. *International Journal of Advanced Research in Management and Social Sciences*, 2(8): 98-103.

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