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Effect of Agricultural Seasons on Energy Intake: Evidence from Two Agro-Ecologically Different Rural Districts of India

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Abstract

Seasonality is recognised as a constraint to agricultural production and food and nutrition security of rural households. It alters the energy intake from different groups of foods based on the availability. These variations in energy intake affect the nutritional status of the population. Eight villages in Wardha district of Maharashtra state and eleven villages in Koraput district of Odisha state were purposefully selected for the study. Foods consumed by households were collected using a semi-quantitative questionnaire in three rounds in 2013-14 and 2014-15 to cover the lean (January-April), planting (May-August) and harvest (September-December) periods in agriculture. Cereals (wheat and rice), pulses, roots and tubers, fats and sugars were consumed daily in Wardha. In Koraput, the daily diet included cereals (rice and finger millet), other vegetables, fats and sugars. Cereals supplied majority of the total energy intake in both the study area (63% in Wardha and 85% in Koraput); the contribution is higher during lean period in Wardha and during planting in Koraput. Significant variation was found in the mean intake of food groups and the energy obtained from them between seasons except for few food groups. It was found to be positive during the planting season in Koraput and negative during lean period and harvest season when compared with the average energy intake across three seasons; in Wardha, energy intake was positive during harvest season followed by lean and was negative during planting season. It was also found that most small land holders (<2 ha) were affected by seasonality. The sourcing of foods and the energy contributed by them to the total energy intake also varied depending on seasons and majority of energy intake was sourced from public distribution system. Seasonality plays a crucial role in energy intake of individuals through fluctuation in availability and accessibility of food; this in turn will impact the nutritional status of the rural population. Energy requirement varies according to seasons as the type of agriculture activity differs. It is important to take seasonality into consideration while designing food-based approaches to combat the problem of undernutrition.

Keywords

Agricultural Seasons, Energy Intake, Landholding Size, Sourcing of Foods

1. Introduction

Asia has the highest population exposed to severe agro-climatic seasonality and the largest number of people at risk of seasonal energy stress [1]. Most rural populations in developing countries suffer from seasonal energy stress because of fluctuation in their access to food, either in absolute terms, such as during the pre-harvest decline in food availability, or in relative terms, because of the increased energy output needed for peak agricultural work, which has been recognized as a contributor to nutrition and health problems [2].

Agriculture plays a vital role in India's economy and over 57.8 per cent of the rural households depend on agriculture as their principal means of livelihood [3]. Seasonality is recognised as a constraint to agricultural production and to household food and nutrition security [4]. Many studies have reported the influence of seasonal fluctuations on food availability, energy and nutrient intake, as well as the body weight of adults and growth of children.

Food security among rural agricultural households during lean seasons is challenging as majority of them rely on rain fed agriculture coupled with poor post season storage capacity or limited market opportunities [5]. The variation in the price of commodities also plays a wider role in household food security. Locke *et al.* [6] conducted a study on agriculture community and stated that the availability of fruits and vegetables in rural communities is high during harvest seasons when farmers markets are flooded with fresh locally grown produce and heightened supply leads to lower prices. Considerable seasonal variation was observed in energy sources in rural areas, less so in urban areas [7].

Larger variation in food consumption between seasons has been reported and this has to be taken into account for dietary studies as intake of nutrients differ between seasons depending on availability of foods [8]. Shively and Hao [9] demonstrated that in Uganda, the planting season was the period of low dietary diversity. There are also other factors aggravating seasonal stress, such as socio economic gradient, gender differences, division of labor etc. The effect of seasonality on food availability and nutritional status is aggravated if the seasonal burdens are unequally distributed between social groups within the society [2]. Pastore *et al.* [10] reported that in the early pre-harvest season, food stocks of poor households were 6.5 times smaller than those of better-off families. In con trast to the above studies, Tin-May-Than and Ba-Aye [11] indicated that food intake in Burmese farming community is not a limiting factor in energy expenditure in different seasons.

Against this backdrop, the present paper assesses the food consumption and energy intake of rural households in the Wardha district of Maharashtra state and Koraput district of Odisha state in India. **Figure 1** shows the study locations in India. The data used in the present paper was collected as a part of baseline survey under a "Farming System for Nutrition (FSN)" study. Agriculture is the primary occupation of the population in both the study locations, implying that agriculture could be a potential solution to combat nutrition and health inadequacies [12]. Agriculture production fluctuates according to seasons and this impacts food availability and food prices which in turn affects food security and the nutritional status. The objective of the present paper is to assess relationship of agriculture seasons and land holding on energy intake and the effect of seasonality on sourcing of foods and the energy obtained from them.

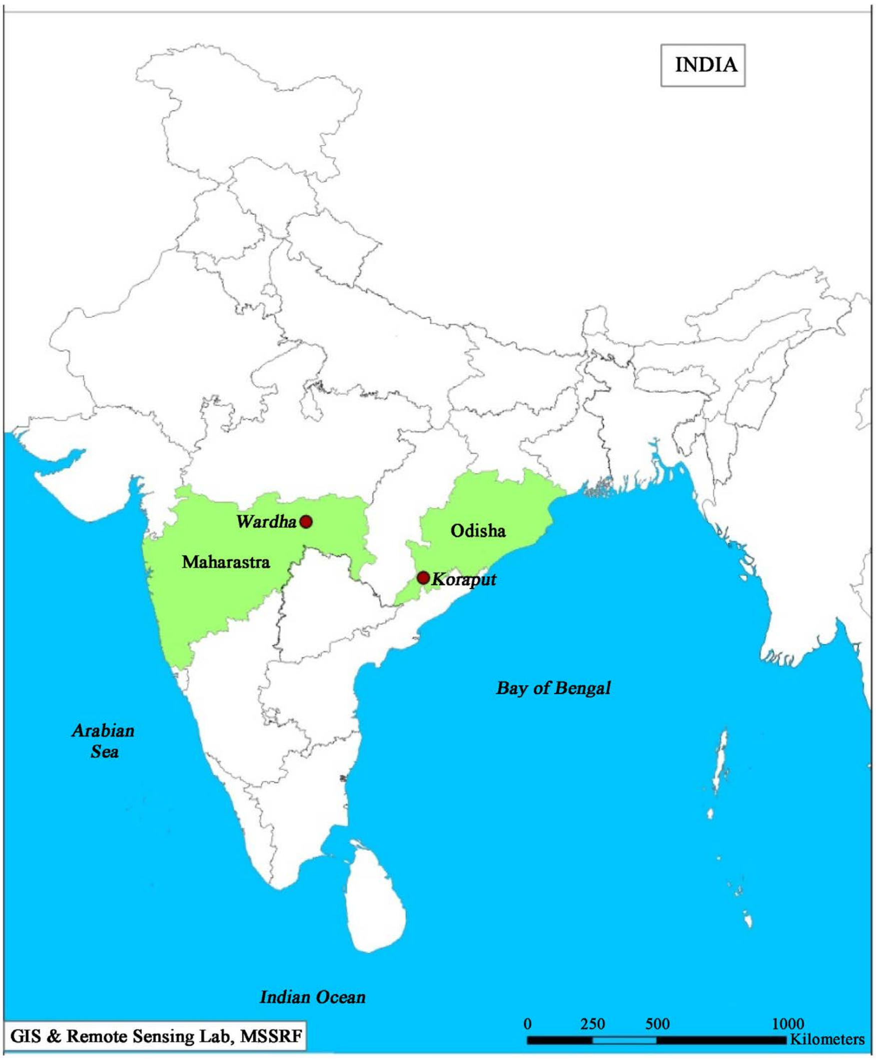

Figure 1. India map showing FSN study locations.

2. Materials and Method

2.1. Study Area

The study locations were purposively selected in 2013, due to their characteristic contrast with regard to agro-climatic and socio-economic status, landholding pattern, farming practices and food consumption pattern. Information on the study locations have been previously reported by Das *et al.* [13] and Nagarajan *et al.* [14]. Both study areas are characterized by rain-fed farming and high levels of undernutrition [12]. Eight villages having 822 households with a population of 3287 in Wardha district, Maharashtra state and eleven villages having 921 households with a population of 3958 in Koraput district, Odisha state were identified for study. A detailed baseline survey was undertaken in 2014, to understand the demographic, socioeconomic, nutritional status and consumption pattern of the population.

2.2. Food Consumption Pattern

The consumption of different foods based on monthly recall was collected using a semi-quantitative questionnaire in 2013-15. Data were collected at three points of time in a year to capture agricultural seasonal variations in food consumption; Lean (January-April), planting (May-August) and harvest (September-December) periods in agriculture. The foods were grouped based on the classification given by Indian Council of Medical Research, National Institute for Nutrition, Hyderabad, India. The energy composition of foods were obtained from the "Nutritive value of Indian Foods" (2012) published by National Institute for Nutrition, Hyderabad.

2.3. Landholding Size

Landholding is the source of income, employment and economic security of most rural people. Since land is the productive asset which mainly determines income distribution and thus access to food in the rural areas; nutrition among rural people is closely related to the size of the land holdings [4]. In the study areas, landholdings are defined as operational land which includes own land as well as leased-in land. The details of the landholding sizes of the study areas are given in **Table 1**. The effect of landholding size on the energy intake is analysed and presented in the paper.

2.4. Statistical Analysis

SPSS (IBM Version 20) and Stata (12.1) were the statistical packages used. Paired T test was performed to assess the significance of food and energy intake between seasons.

3. Results and Discussion

3.1. Socio-Demographic Profile of the Population

The characteristics of the households in the study area are given in **Table 1**. Both the study locations are dominated by Scheduled tribes, 49% in Wardha and 44%

Table 1. Characteristics of the population in the study area.

	Wardha n = 822	Koraput n = 921
Social Group		
Scheduled Caste	107 (13.0)	120 (13.0)
Scheduled Tribe	401 (48.8)	406 (44.1)
Other Backward Castes	142 (17.3)	372 (40.4)
Others	172 (20.9)	23 (2.5)
Age Group		
0 to 5 Years	282 (8.6)	472 (11.9)
6 to 11 Years	255 (7.8)	588 (14.9)
12 to 17 Years	345 (10.0)	501 (12.7)
18 to 44 Years	1435 (43.7)	1524 (38.5)
>=45 Years	970 (29.5)	873 (22.1)
Gender		
Male	1722 (52.4)	1874 (47.3)
Female	1565 (47.6)	2084 (52.7)
Head of the Household Occupation		
Cultivation	470 (57.2)	520 (56.5)
Agriculture Wage Labour	314 (38.2)	122 (13.3)
Artisans/Independent Work	9 (1.1)	13 (1.4)
Non-Agriculture Wage labour	6 (0.7)	173 (18.8)
Others	23 (2.8)	93 (10.1)
Head of the Household Education status		
Illiterate	182 (22.1)	609 (66.1)
Primary	378 (46.0)	239 (26.0)
Upper Primary	189 (23.0)	60 (6.5)
Higher Secondary	49 (6.0)	4 (0.4)
Graduate & above	24 (2.9)	9 (1.0)
Land Classification		
Landless	306 (37.2)	153 (16.6)
Marginal (<1 ha)	83 (10.1)	743 (80.7)
Small (1 to <2 ha)	213 (25.9)	20 (2.2)
Semi-Medium (2 to <4 ha)	155 (18.9)	5 (0.5)
Medium (4 to <10 ha)	60 (7.3)	0
Large (10 ha & above)	5 (0.6)	0
Home Garden		
Yes	124 (15.1)	446 (48.1)
No	698 (84.9)	475 (51.6)
House Type		
Kuccha	414 (50.4)	524 (56.9)
Semi-Pucca	352 (42.8)	379 (41.2)
Pucca	56 (6.8)	18 (2.0)
Food Expenditure (Rs.)		
<1000	35 (4.3)	285 (30.9)
1000 to <2000	315 (38.3)	509 (55.3)
2000 to <3000	338 (41.1)	101 (11.0)
>=3000	134 (16.3)	26 (2.8)

Figure in parenthesis denotes percentages; Source: Bhaskar *et al.* [12].

in Koraput. As mentioned earlier both the locations are rainfed areas. Most of the households in Wardha did not have home gardens; however, 48% of households in Koraput had home gardens as it was a part of their socio-cultural practice.

Cultivation was the major occupation in both the locations followed by agriculture wage labour in Wardha and non agriculture wage labour in Koraput. About 37% of the households in Wardha were landless and 36% were small land holder (<2 ha). In Koraput, 83% of the households owned less than 2 hectare land.

Cotton, pigeon pea, soya bean, sorghum was grown in *Kharif* season (July-October during the south-west monsoon) and wheat and Bengal gram in *Rabi* (October-March (winter)) in Wardha. In Koraput, rice and finger millet were grown as *Kharif* crops and groundnut, greengram, maize, finger millet and black gram were grown as *Rabi* crops. Detailed characteristics of the study area and agricultural pattern are given in Bhaskar *et al.* [12].

3.2. Food Consumption and Energy Intake Based on Agricultural Seasons

The average intake of food groups and the energy provided by them and the percentage share of each food group to total energy intake per day based on agricultural seasons in Wardha and Koraput is shown in Table 2 and Table 3, respectively.

1) Wardha

Wheat followed by rice was the staple food in Wardha. In addition to cereals,

Table 2. Average intake (g/CU/day) of food groups, energy (kcal/CU/day) provided by foods and energy (%) contributed by different food groups based on different agriculture seasons in Wardha.

Food Groups	Average Intake of Foods (g/CU/day)				Average Energy Intake (kcal/ CU/day)		
	Harvest	Lean	Planting	RDI*	Harvest	Lean	Planting
Cereals & Millets	425.4	464.6	349.5	375	1456.0 (62.3)	1588.8 (64.3)	1195.3 (62.5)
Pulses & Legumes	59.0	40.6	44.1	75	187.6 (8.0)	141.4 (5.7)	151.7 (7.9)
Vegetables	184.4	160.8	142.5	500[#]	87.5 (3.7)	78.8 (3.2)	62.0 (3.2)
Fruits	35.7[a]	36.8[a]	30.2	100	17.9[a] (0.8)	20.1[a] (0.8)	15.7 (0.8)
Animal Foods	77.4	65.1	76.6	100[$]	67.4 (2.9)	57.6[a] (2.3)	58.1[a] (3.0)
Edible fats & Oils	38.7	42.9	28.4	25	342.7 (14.7)	386.0 (15.6)	255.4 (13.4)
Sugars	44.5[ab]	50.2[a]	43.8[b]	20	176.7[ab] (7.6)	198.9[a] (8.0)	172.8[b] (9.0)
		Total			2335.8	2471.6	1910.9
						RDA* 2320	

Source: FSN baseline study (2013-15); Figures in parenthesis represent percentages; CU: consumption unit. *Recommended Dietary Intake (RDI) & Recommended Dietary Allowance (RDA) given by National Institute of Nutrition, Indian Council of Medical Research, Hyderabad; [#]100 g green leafy vegetables, 200 g roots and tubers, 200 g other vegetables; [$]Fish and sea foods and meat and poultry (no RDI); milk and milk products (100g RDI); [ab]alphabets represent the non significance; otherwise significance @ $p < 0.05$.

Table 3. Average intake (g/CU/day) of food groups, energy (kcal/CU/day) provides by foods and energy (%) contributed by different food groups based on different agriculture seasons in Koraput.

Food Groups	Average Intake of Foods (g/CU/day)				Average Energy Intake (kcal/ CU/day)		
	Harvest	Lean	Planting	RDI*	Harvest	Lean	Planting
Cereals & Millets	497.5	521.7	613.3	375	1680.5 (83.1)	1784.1 (86.3)	2091.8 (84.0)
Pulses & Legumes	21.4[a]	14.8	22.1[a]	75	74.6[a] (3.7)	51.0 (2.5)	76.0[a] (3.1)
Vegetables	230.4[a]	253.3	238.5[a]	500[#]	113.5 (5.6)	107.8 (5.2)	128.7 (5.2)
Fruits	8.2	10.8	71.2	100	7.8 (0.4)	9.7 (0.5)	42.9 (1.7)
Animal Foods	22.2[a]	19.6[a]	37.0	100[$]	26.9 (1.3)	23.9 (1.2)	42.6 (1.7)
Edible Fats & Oils	8.0	6.0[a]	6.0[a]	25	71.9 (3.6)	54.3[a] (2.6)	54.3[a] (2.2)
Sugars	11.7	9.2	13.3	20	46.3 (2.3)	36.4 (1.8)	52.9 (2.1)
		Total			2021.5	2067.2	2489.2
						RDA* 2320	

Source: FSN baseline study (2013-15); Figures in parenthesis represent percentages; CU: consumption unit. *Recommended Dietary Intake (RDI) & Recommended Dietary Allowance (RDA) given by National Institute of Nutrition, Indian Council of Medical Research, Hyderabad; [#]100 g green leafy vegetables, 200g roots and tubers, 200 g other vegetables; [$]Fish and sea foods and meat and poultry (no RDI); milk and milk products (100 g RDI); [ab]alphabets represent the non significance; otherwise significance @ $p < 0.05$.

their daily diet consisted of pulses and legumes, roots and tubers, oil and sugars. Vegetables like onions, potatoes and brinjal, tomatoes and fruits like lemon were majorly consumed. It was observed that Wardha has a cereal based diet and cereals were consumed in higher amount than the recommended levels during harvesting and lean seasons. But it was lesser during planting season; this may be because Wardha has a commercial cropping pattern and expenditure on inputs for the cultivation of commercial crops compromise food expenditure. However, in lean season when the availability was less, foods were procured from PDS. Fats and sugars were consumed in higher quantities, more than the recommended levels irrespective of seasons; only during planting season consumption was slightly lesser than the recommended levels. High priced foods like pulses, vegetables and animal foods were consumed in higher quantities during harvesting season, due to the availability of money by selling their commercial produce. Similar result of higher consumption of vegetables during harvesting season irrespective of their source was reported by Locke *et al.* [6].

Significant difference was observed between the mean quantities of foods consumed between agricultural seasons and the energy provided by the food groups except for fruits (between harvest and lean period) and sugars (between harvest and lean period; planting and harvesting period) (**Table 2**). The energy provided by animal source foods in lean and planting period was same and lesser when compared to harvest season.

Overall in Wardha, the average consumption of cereals was 413 g/CU/day, which provided 1413 kcal/CU/day and 63% of total energy intake/day. Kearney [15] reported that cereals continue to remain the most important food source and contributed 70 per cent of energy intake in parts of Asia. The remaining energy was contributed by fats (15% of total energy/CU/day), sugars (8%), pulses (7%) and vegetables (5%). The total energy intake was lowest during planting season (1911 kcal/CU/day) due to less food availability as well as less time diverted towards food preparation, as the period coincides with peak agricultural seasonality such as field preparation, sowing, planting, weeding, spraying etc. The inverse relationship of energy demand with food supply was also reported by Kigutha [4].

However, the energy intake met the RDA during harvesting and lean period mainly due to greater availability of foods. Stelmach-Mardas *et al.* [16] also reported that post harvest season is associated with increased energy intake.

2) Koraput

Similar to Wardha, the diet is cereal based in Koraput. Households have rice as staple food followed by finger millet and were consumed at higher quantities. Consumption of all other food groups was less than recommended levels. In contrast to Wardha, higher quantities of cereals, pulses, fruits, animal foods were consumed during planting season, while vegetables were consumed in higher quantities during lean period. Fats and oils were consumed in higher quantities during harvest season, as they were more affordable during this period.

There was significant difference between the mean quantities of foods consumed between agricultural seasons and the energy provided by the foods except for pulses and vegetables (between planting and harvest), animal foods (between harvesting and lean) and fats and oils (between lean and planting) (**Table 3**).

In Koraput, the average consumption of cereals and millets was 544 g/CU/day which provided 1852 kcal/CU/day and contributed 85% of total energy. Remaining energy was contributed by vegetables (5%) and pulses, sugars and fats (3% each). Highest energy intake was seen during harvesting season as the availability of foods is surplus. Tetens *et al.* [17] reported similar situation in Bangladesh that the dietary energy contribution from rice was 80% in both lean and peak seasons. Teokul, *et al.* [18] reported that there was less variation between seasons if there was a single crop; for example, in Bangladesh where there are two rice crops each year, the variations in food intake are much less. For rural households in Ethiopia, the mean daily per capita energy intake was 2459 kcal in February (post-harvest period) and lower at 2319 kcal in June (lean season) [7].

Overall, there was not much change in the percentage contribution of different food groups to the total energy intake in different seasons; however fluctuation was seen in quantities and the energy contributed by each food group in both study areas.

Seasonal variation in food intake and consumption at less than the recommended levels in Swazi households was demonstrated by Huss-Ashmore and Curry [19]. Tetens *et al.* [17] stated that the energy intake particularly in children and adolescents of Bangladesh, were significantly higher in the peak seasons (post harvest), when the food was abundant and rice prices were low than in lean season.

Figure 2 shows the mean difference of energy intake in a season from average intake during the year *i.e.* across 3 seasons. It can be observed that in Koraput, during harvest season, the energy intake was deficit (−171.2 kcal/CU/day) followed by lean season (−125.5 kcal/CU/day), the reason being availability and affordability. Rossato *et al.* [20] reported higher carbohydrate intake in summer over other seasons in Brazilian adults.

In contrast to Koraput, in Wardha, positive energy intake (+232.1 kcal/CU/day) was observed during lean season followed by harvest season (+96.4 kcal/CU/day). The intake of energy was deficit by −328.5 kcal/CU/day, during planting season. The rainy season is the time of year when food is most needed for work, but it is also the hungry season when food is shortest and most expensive [21].

Murayama and Ohtsuka [22] demonstrated that inter-season differences of mean total energy intake were significant between pre-harvest and harvest seasons and between harvest and rainy seasons among women farmers (+1.08 MJ and −0.69 MJ, respectively).

3.3. Relationship between Landholding and Agricultural Seasons on Energy Intake

Association of land size and agriculture seasons on energy intake is given in Figure 3.

Earlier studies had demonstrated the relationship between landholding and food security. Muraoka *et al.* [23] demonstrated that a 10% increase in operational land size increased per capita total consumption and per capita home-produced food consumption by 0.8% and 2%, respectively. In the present study, the mean energy intake during harvesting season in households having more than 2 hectares of land was higher in Wardha followed by landless and those with less than 2 hectare of land. During lean and planting period, energy intake was high in landless households followed by households having more than 2 hectare land. This might be due to engagement of landless households in

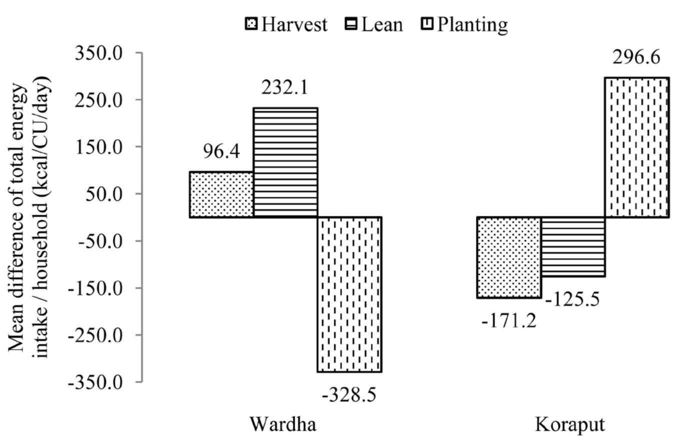

Figure 2. Mean difference in total average energy intake (kcal/CU/day) across agricultural seasons.

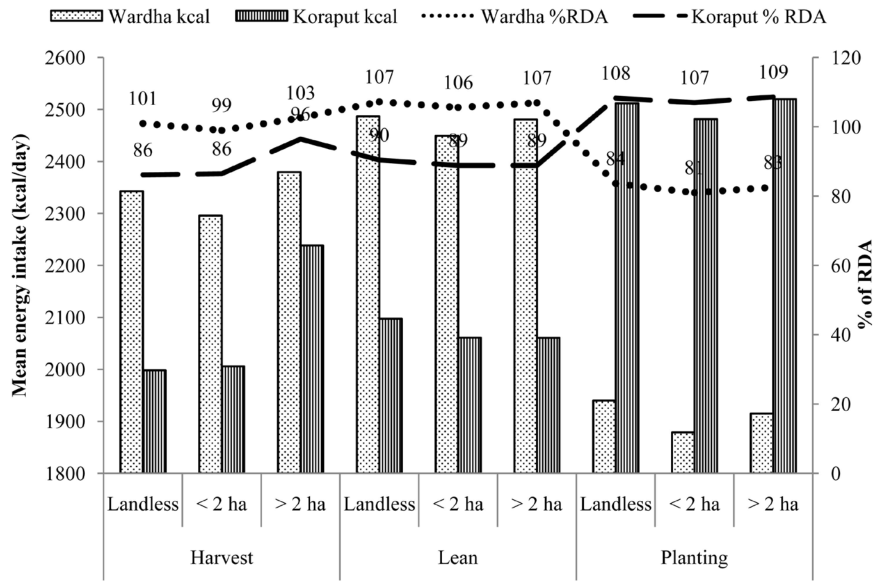

Figure 3. Mean energy intake (kcal/CU/day) and percentage of RDA depending on agriculture seasons and land size.

non-agricultural activities during lean periods and waged agricultural activities during peak periods, thereby not being affected by agricultural seasons. In many societies, the better-off farmers hired people from lower socioeconomic strata to do the agricultural work [2] and labourers benefit being able to get work. Access to off-farm or non-agricultural employment and income sources have smoothing effects on adverse seasonality [21]. Handa and Mlay [5] also reported that households with off-farm employment display less seasonal variation in consumption over the year compared to households without an off farm income source. Overall, the small and marginal land holders having less than 2 hectares of land were having lesser energy intake across all agricultural seasons. Herrero [24] reported small holders were the most affected by food insecurity and indicated small farm sector as a crucial entry point for policy interventions to improve food security and nutrition. The pre-harvest crisis might sometimes be more acute for self-provisioning small farm families than for landless labourers as the small farm families rely on their harvest for food and income, and may be driven to employ labour at a time when they are very short of money [21].

In Koraput, households having more than 2 hectare land consumed more energy during planting season followed by harvest season, than landless and households having less than 2 hectare of land. In lean season, the landless consumed more energy than land holders.

Overall, in Wardha, the landless households and more than 2 ha land holders consumed the recommended levels of energy intake during harvest and lean period and consumed 84% and 83% of RDA respectively; while, the households having <2 ha land consumed energy that met 81% during planting period. In Koraput, during planting period, the energy intake met RDA, irrespective of land holding size. Energy intake was 86% of RDA during harvest period by landless and less than 2 ha land holders, while it was 96% of RDA by more than 2 ha land holders; while in lean period, it was 88% of RDA by land holders and 90% of RDA by landless households. Singh *et al.* [25] reported consumption of 92% of RDA by landless agricultural wage labourer followed by small farmers (90% of RDA) and medium farmers (84% of RDA) in lean season and 94% RDA by landless agricultural wage labourer, 93% RDA by small farmers and 87% of RDA by medium farmers in peak season.

3.4. Effect of Agricultural Seasons on Sourcing of Food and Energy

Comparatively, Koraput being a subsistence farming area, the sourcing of foods from own production was more prevalent than in Wardha where commercial farming system dominates and there is more dependence on market. Sharing and exchange of foods among households was found to be less in both locations irrespective of seasons. Although the villages were near the forest, the collection and consumption of wild foods were negligible, with minimal contribution towards total energy intake. Public distribution system (PDS) with rice at Rs.2/kg being given in Koraput and Wardha and wheat at Rs.3/kg in Wardha, played a wide role in both locations irrespective of agricultural seasons.

In Koraput, major proportion of energy intake was sourced from PDS and market (63% of RDA in harvesting; 70% in lean; 74% in planting) followed by PDS alone or PDS and home grown whereas in Wardha, its inverse, the households depend mostly on PDS and home grown (57% of RDA in harvesting; 48% in lean; 32% in planting) followed by PDS and market and PDS alone for their energy requirements.

Figure 4 shows the energy obtained from different sources and the percentage contribution against RDA.

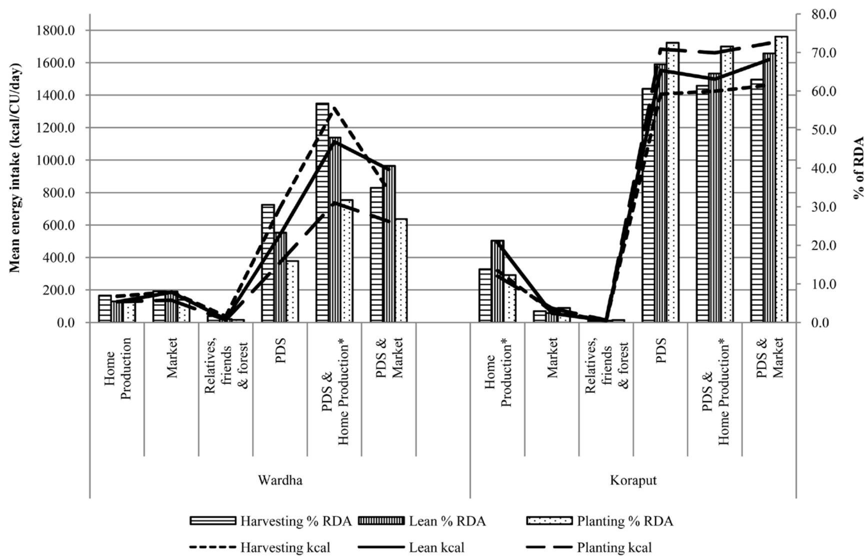

Figure 4. Mean energy intake (kcal/CU/day) obtained from different sources and the percentage of RDA based on agricultural seasons. *backyard or own field production; #neighbours, relatives or forest.

Sibhatu and Qaim [26] reported that in Ethiopia, the average, subsistence production accounted for 58% of rural households' calorie consumption; 42% of the calories consumed were from purchased foods; during the lean season, purchased foods accounted for more than half of all calories consumed.

4. Conclusions

The results of the present study show that seasonality plays a wider role on the energy intake from different food groups and from different sources. In addition to seasonality, land size also affects the energy intake across all seasons. The type of farming system, subsistence or commercial, also showed effect on the energy intake; Wardha having a commercial cropping pattern showed positive during harvest season followed by lean and was negative during planting season. Koraput having a subsistence farming system showed higher energy intake during planting season. In both locations, pulses, vegetables, fruits, fish, meat and milk consumption was less than RDI consumed. Government initiative particularly public distribution system helps in steady supply of cereals (rice and wheat) irrespective of seasons.

Seasonality in agriculture production implies fluctuations in food supply and food availability. After the harvest, during lean period, there is usually enough food for some time which is demonstrated in Wardha. But during the following wet season food stocks slowly get depleted with food becoming scare during the next few months before the harvest begins particularly in areas having unimodal climates [2]. One rainy and one harvest season a year, reduce the optimal period for plant growth and thereby oblige the farming communities to engage in short intensive bouts of agricultural activities. The period of intensive agricultural work coincides with the time of the year when food stocks at the household are at their lowest levels, lean season followed by planting season. By influencing food availability and activity patterns, seasonality affects energy and nutrients intakes, as well as the energy expenditure and the nutritional status. Seasonal variation in food availability has long been recognized as a contributor to energy and thereby influencing nutrition. Overall the study findings contribute to the growing literature that attempts to understand the role of food intake in improving food and nutrition security across seasons particularly in a population dependent on agriculture for livelihood.

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