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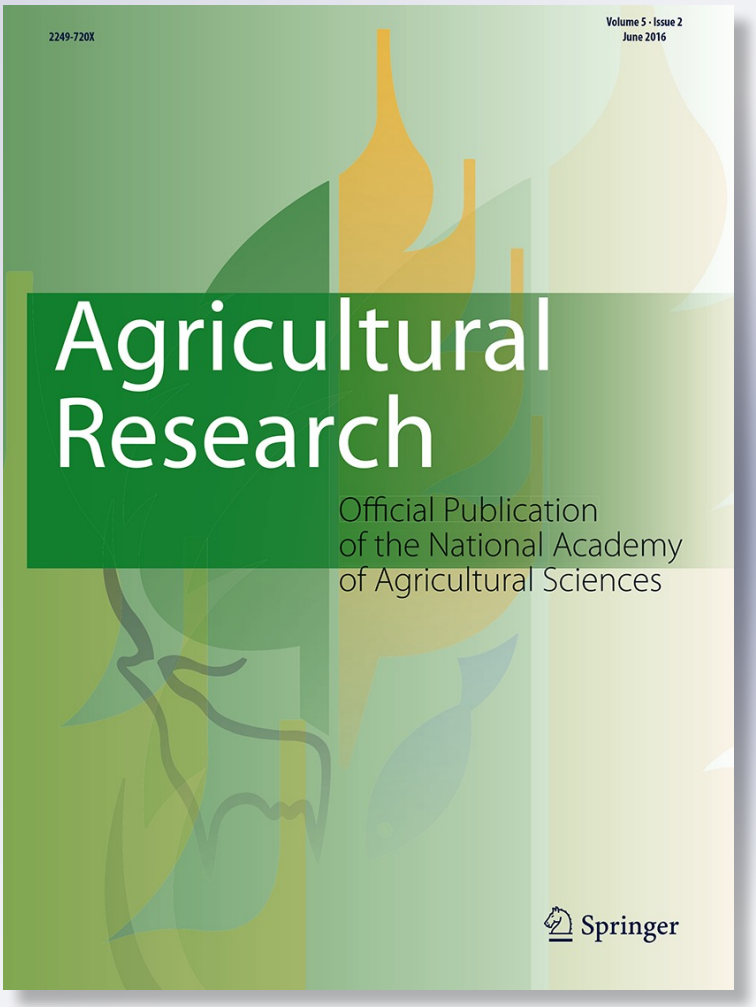

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FULL-LENGTH RESEARCH ARTICLE

Impact of Enriching the Diet of Women and Children Through Health and Nutrition Education, Introduction of Homestead Gardens and Backyard Poultry in Rural India

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Abstract The study addresses the issue of micronutrient deficiency in diets through health and nutrition education and introduction of homestead gardens and backyard poultry with high egg-yielding birds in a rural community. The target was the pregnant women and mothers with preschool children aged 6–24 months registered with the 11 Integrated Child Development Services (ICDS) centres called 'Anganwadi' in eight villages of Medak district, in the South Indian state of Andhra Pradesh (now Telangana). Knowledge, attitude and practice (KAP) surveys of health and nutrition on a sub-sample of 142 mothers with 6- to 24-month-old children done initially and at the end of three years showed marked improvement in mothers' knowledge and child-feeding practices. At the end of three years, 335 target families had raised vegetable gardens diverting 57.8 acres of land. The KAP survey responses showed that the percentage of families raising homestead gardens increased from 30 % initially to over 70 % finally. Weekly mean frequency of green leafy vegetables (GLV) cooked, increased from 1.9 to 2.4. The percentage of households cooking GLV more than three times per week increased from 21 in the initial survey to 45 in the final survey. Weekly frequency and quantity of eggs consumed, among households who set up BYP, more than doubled. ICDS records showed gradual decline in percentage of 6 to 24-month-old children suffering from moderate-to-severe malnutrition, over the three-year experimental period.

Keywords Dietary micronutrient deficiency in India · Homestead gardens · Backyard poultry · Health and nutrition education · Integrated Child Development Services - Anganwadi · Knowledge, attitude and practice survey · Preschool children nutrition status

Abbreviations
AICRP: All India Coordinated Research Project; ASHA: Accredited Social Health Activist; BYP: Backyard poultry; GLV: Green leafy vegetables; ICDS: Integrated Child Development Services; KAP: Knowledge, attitude and practice; LBW: Low birth weight

Introduction

Surveys in India show that Indian diets, particularly those of pregnant and lactating women and preschool children, are qualitatively very deficient in micronutrients (vitamins and minerals) particularly iron, vitamin A, vitamin B_2 and folic acid due to low intake of vegetables, fruits, legumes (pulses) and livestock-based foods [5]. In recent years, the problem of deficiency of vitamin D and B_{12} has also emerged. These vitamins are not found in plant foods, pointing to the importance of animal foods. The Integrated Child Development Services (ICDS) scheme in India addresses the dual issue of maternal and child nutrition and child development through supplementary feeding programmes and non-formal education for preschool children. Pregnant women and mothers of preschool children in rural and urban areas are invited to register at the ICDS centres

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called Anganwadi, at no cost. Supplementary food containing a mixture of cereals, pulse ('dal') and sometimes vegetables is given to children over the age of 2 years during the day to eat it at the Anganwadi. Some states like the erstwhile Andhra Pradesh also give eggs once or twice a week. Take-home food is given for children under the age of 3 years and pregnant and lactating women. This is often shared by the family.

A programme of home gardens and backyard poultry coupled with nutrition education was implemented in Bangladesh, Cambodia, Nepal and the Philippines, by the Helen Keller International to increase access to micronutrient-rich foods in poor households particularly among women and children [3, 7, 8]. There was a quantum increase in the weekly consumption (frequency as well as quantity) of dark green leafy vegetables (GLV) and eggs consumed by mothers and preschool children [3]. KAP surveys showed improvement in mothers' knowledge of nutrition. Significant reduction in the prevalence of anaemia was seen in Bangladesh and Philippines [8]. Homestead farming has been reported to contribute significantly to food security and income in a developing economy like Nigeria. [6]. A 'Farming system model to leverage agriculture for nutritional outcomes' has been recently suggested by MS Swaminathan Research Foundation [2].

In the past several years, we have examined the feasibility of 'crop diversification from agriculture to nutritionally and environmentally promotive horticulture' by motivating small and marginal farmers from villages of Medak district in South Indian state of Andhra Pradesh (now Telangana), to divert small parts of their land from traditional water-guzzling crops like paddy and sugar cane to homestead (near home, or in farmers' fields) cultivation of micronutrient-rich vegetables and fruits using environmentally sustainable farming practices. Such diversification we explained would not only improve access to nutritious vegetables and fruits for home consumption, but also conserve groundwater—the major source of water for irrigation. Apart from transfer of farm-based technologies, the community was educated on issues of health and nutrition. Need for home consumption, particularly by women and children for nutrition and health, was stressed [1].

With some persuasion, many households did divert small patches of land (0.125–0.25 acres) to raising vegetables and fruit gardens. Though a family approach was used, male members of the family dominated and came for the training programmes. Household food consumption survey showed marked increase in the weekly consumption (frequency and quantity) of green leafy vegetables (GLV) in the end-line survey, done after 3 years compared to initial (baseline) survey. Consumption of other vegetables showed little change. However, in the non-participating households, there was marked decline in the consumption of vegetables over the 3-year project period, probably due to escalating market price of vegetables. Thus, it appears that homestead production at least protects the families from the inflation-induced increase in market price of vegetables [1].

In the same villages, backyard poultry (BYP), using high egg-yielding breeds, was introduced, by selling few birds to each household. One cock was given free by way of incentive. Egg is a very wholesome food rich in good quality protein and all vitamins and minerals, including vitamins A, B_2, B_{12} and D. Families who raised poultry showed almost 40 % increase in the frequency as well as weekly consumption of eggs, suggesting BYP to be a promising intervention for household food security [4].

Nutritionally speaking, pregnant and lactating women and preschool children, particularly 6–24 months old, are among the most vulnerable groups. Since women have the primary responsibility of home keeping and child rearing, the present study was specifically targeted to pregnant women and mothers of 6- to 24-month-old children who had registered in ICDS centres. Homestead gardens of vegetables and fruits and backyard poultry (BYP) with high egg-yielding breeds were promoted. Health and nutrition education was important part of the study. For nutrition security, access to safe drinking water and disease-free environment besides balanced diet are necessary.

Methodology

Project Area

Eleven well-performing Anganwadi (ICDS Centres) operating in eight villages with population ranging from 1000 to 3000 (total population 12,000) were selected from two mandals (geographical area covering population of approximately 25,000) of Medak district of the South Indian State of Andhra Pradesh (now Telangana). All the households were below the poverty line and majority belonged to backward class communities (69 %) or schedule cast (15 %) or schedule tribes (17 %). All the villages had a primary school. Farming using bore well water was the major occupation. Paddy, sugar cane and maize were the major crops grown. Small quantities of red gram were grown by intercropping with maize. Some families raised vegetables in monsoon and winter.

Initial and End-Line Knowledge, Attitude and Practice (KAP) Surveys

All pregnant women and mothers with preschool children in the age group 6–24 months registered at the 11

Anganwadi were included in the study. A baseline KAP survey was conducted on a sub-sample of every alternate mother with preschool children aged 6–24 months (total of 142) to find out, information regarding educational level, occupation, type of house, presence of bathrooms and toilets, land holdings, cropping practices, etc. KAP information with regard to health and nutrition knowledge, infant-feeding practices, hygienic practices, knowledge of common communicable diseases, etc. was also elicited. A household food frequency diet survey was done to assess the impact on consumption of vegetables including GLV. Due to paucity of material and human resource, the KAP study had to be confined to a subsample of mothers of 6- to 24-month-old children. The age group—6–24 months—is regarded to be most vulnerable from nutrition point of view. An end-line KAP survey was repeated on 142 mothers with 6- to 24-month-old children to assess the improvement in knowledge and practices. Both the surveys were cross sectional.

The data were analysed for statistical significance using two-sample proportion Z test.

Introduction of Homestead Gardens

Seeds of vegetables like a variety of green leafy vegetables (GLV) (Amaranth—*Amaranthus gangeticus;* Ambat chuka—*Rumex vesicarius;* corrriander—*Coriandrum sativum;* fenugreek—*Trigonella foemum graecum;* 'gogu'—Hibiscus, *cannabinus*; spinach—*spinacia aleracea);*broad beans—*Vicia faba;* cluster beans—*cyamopsis tetragonolova;* French beans-*phaseolus vulgaris;* tomatoes—*lycopersicon esculentum;* ladies finger (okhra)—*abelmoschus esculentus;* and saplings of curry leaves—*Murraya koenigii;* drum stick—M*oringa oleifera;* Malabar spinach—*Basella alba;* and fruits like guava—*Psidiunm cattleyanum*; mango—*Magnifera indica*; papaya—*Carica papaya*; and lime—*Citrus aurantifolia* were distributed to families with a pregnant woman or 6- to 24-month-old children who were willing to raise homestead gardens. Fruit plants were selectively given only to families who had assured source of water and performed well, since grafted plants are expensive. GLV are a treasure trove of most micronutrients–vitamins and minerals. They are easy to grow and can be grown almost throughout the year. Other vegetables like beans, tomatoes and okra are also rich source of vitamin C and minerals. Beans are also rich in proteins. Papaya and mangoes are rich in β carotene (pro-vitamin A) and vitamin C and guava in vitamin C. Farmers grew vegetables like brinjal (egg plant) and gourds out of choice. Few households had one or two trees of plants like papaya, mangoes, guava, drumstick (Moringa) and curry leaves prior to intervention. Twenty-four women were taught to raise nurseries of plants like papaya, drumstick and Malabar spinach (Basella alba), by giving seeds and sachets. Each woman raised 50–100 saplings, and these were purchased from her at Rs 5/sapling. These served as planting material for distribution and women who raised them earned some money through supply of saplings.

Introduction of Backyard Poultry with High Egg-Yielding Breeds of Birds

High egg-yielding breeds of poultry like Rajasree developed by AICRP on Poultry, Hyderabad, and Rainbow rooster from Inbro Research and Breeding Farm, Hyderabad, were obtained. These breeds lay over 160 eggs per year compared to 30–40 eggs laid by country birds. Initially, 1-day-old chicks of Rajasree breed were purchased by an experienced local farmer, raised them to the age of 2.5 months and sold to the interested families in the project villages. Subsequently, older birds of Rainbow rooster purchased from Inbro Research and Breeding Farm were sold to the families. Each family purchased four female birds. One male bird was given free as incentive. Records of egg consumption by the family were maintained. Note books were given to 15 educated farmers to maintain records of the eggs produced daily. It was not possible to get this information reliably from all the farmers.

Health and Nutrition Education: Methodology

Centralised training at the Dangoria Charitable Trust, centre in village Narsapur, Medak district, and decentralised, hands-on training in the villages or in the 'anganwadi' centres using focus group discussions, slide and video shows and demonstrations were conducted. For centralised training, the women were given transportation charge and some food. Separate training programmes were held for the Anganwadi workers (ICDS teachers) and ASHA (Accredited Social Health Activists) workers from the same villages, to help them work in tandem, and with the community.

Besides transfer of farm technologies, cooking demonstrations showing preparation of recipes incorporating vegetables, particularly GLV, were held. Mothers came to these programmes with their infants and participated in infant and child feeding. Open-air slide and sound and video shows were conducted in the evenings in the villages. These were open for all. Health and nutrition education/communication to the community in general and mothers and pregnant women in particular were important part of the project. Based on identification of knowledge gaps in the initial KAP survey, educational pamphlets, in the local language Telugu, were prepared and distributed. Fortunately, there has been remarkable improvement in

literacy among women from earlier observed less than 20–69 % in the present project. This helped communication. Even illiterate women took the pamphlets home where there was someone who could read and explain.

Assessment of Impact on Child Nutrition

Impact on the incidence of low birth weight (LBW) was assessed from the records of birth weight in the 'Mother and child protection card' given to each mother registered at the ICDS centre. Since the study was primarily targeted to mothers with preschool children besides pregnant women registered at the ICDS centres, impact on growth of 6- to 24-month-old children was assessed from the growth charts (weight for age) maintained by the Anganwadi teacher for each child. This was felt to be an independent and investigator bias-free approach. Auto-regressive integrated moving average (ARIMA) model was used to test the significance of change over time. Assessment of micronutrient status could not be done due to limitation of human and financial resource.

Results

Land Holding

Among the 142 households of mothers with 6- to 24-month-old children surveyed (KAP survey), 18.31 and 11.97 per cent households were landless in the initial and final surveys, respectively. The rest had own or leased land. The mean and range of land among the land-holding families was 1.73 acres (range 0.125–15 acres) initial survey and 1.79 acres (range 0.25–20 acres) final survey. Land-holding families also worked as wage labourers. Only 6 % families were artisans and 2.8 % employed in service (initial survey data). There are no major handicrafts in these villages. About 29 % women were housewives at the time of survey, but all women went to work once the child was grown.

Acceptance of Farm Technologies

Homestead Gardens

Overall at the village level, at the end of 3 years, 335 families with either a pregnant woman or 6- to 24-month-old children had raised vegetable gardens diverting 57.85 acres of land from traditional crops, while initially only 30 % mothers in the KAP survey reported having homestead gardens; after 3 years of intervention, more than 70 % respondents (142 women with 6- to 24-month-old children) had started raising vegetables and fruit gardens.

Backyard Poultry

Almost 25 % families had country poultry with nondescript birds. Initially, only few families had poultry with high egg-yielding birds. At the end of 3 years of project, 150 households with preschool children had established poultry units with high egg-yielding birds with proper night shelters made of wood, or brick and cement. Records of egg production maintained by the fifteen educated farmers who were given a note book to record daily production of eggs showed that on an average these birds laid 14–15 eggs per month. Maximum egg-laying period is 52 weeks. Some birds were lost due to predation (despite night shelters) or disease or slaughtered. Reliable records of these losses or total number of eggs produced could not be maintained. Some farmers sold the fertilised eggs (since a cock was also given) at Rs. 5 each for hatching and also hatched some eggs themselves. However, since the free-roaming female birds were not protected from the local male birds, purity of the breed cannot be maintained and a mechanism has to be developed to ensure continuous supply of fresh stock of female birds or protection from nondescript male birds.

Results of KAP Survey

Mothers' Knowledge, Attitude and Practice (KAP) Regarding Health and Nutrition

The initial KAP survey of mothers with 6- to 24-month-old children revealed some existing positive trends like at least three antenatal check-ups for almost all pregnant women, good immunisation coverage for infants, regular consumption of iron–folic acid tablets by pregnant women, early (day 1) initiation of breast feeding, and recording of birth weight. However, knowledge gaps and wrong-feeding practices such as food taboos during pregnancy, late introduction of complementary feeding, poor understanding of a balanced diet and child-feeding practices, and poor intake of protective foods existed. With education of the mothers during the project period, the end-line KAP survey showed considerable improvement in several indicators. Thus, while in the initial survey, only 38 % mothers reported initiating breast feeding within 1 h after birth as per WHO guidelines; in the final survey, the number increased to 87 %. There was a significant improvement in the percentage of mothers who did exclusive breast feeding for 6 months and reduction in introducing pre-lacteal foods

Table 1 Knowledge, attitude and practice of food consumption practices, food taboos during pregnancy and infant-feeding practices in mothers with 6- to 24-month-old children

Parameter	Initial % respondents	Final % respondents
Number of respondents	142	142
More food should be consumed during pregnancy	18	64***
Papaya avoided during pregnancy	88	76**
Banana avoided during pregnancy	75	35**
Discard excess water from rice after cooking	89	30**
Pre-lacteals given	29	1.41***
Complementary food started at 7 months of age	16	68***
Frequency of complementary feeding >3 times	43	64***
Mean frequency of cooking vegetables per week	3.1 ± 0.64	2.48 ± 0.50***
Frequency of cooking vegetables two times per week	10	52***
Frequency of cooking vegetables three times or more	88	48***
Mean frequency of cooking GLV per week	1.9 ± 0.73	2.39 ± 0.594***
Frequency of cooking GLV two times per week	49	49
Frequency of cooking GLV three times or more	21	45***

** $P < 0.001$; *** $P < 0.0001$, by two-sample proportion Z test

(Table 1). There was a significant improvement in knowledge and practices like a pregnant woman should eat more food, initiation of complementary feeding by age 7 months, frequency of complementary feeding (Table 1), and components of a balanced diet.

However, some beliefs like avoidance of papaya during pregnancy are hard to change.

All mothers reported cooking vegetables, GLV and dal (soup made from a pulse), at least once a week and majority twice or thrice. There was a significant increase in the mean frequency of cooking GLV as well as percentage of mothers who cooked GLV three times or more (Table 1). Surprisingly, there was decline in the frequency of cooking other vegetables. Despite stressing the importance of consuming home-grown vegetables at home, particularly by women and children, over 25–50 % families sold home-grown vegetables. In resource-poor families, income takes priority over reasoning of nutrition and health.

In general, most families consume little milk daily in tea, which children also drink. Meat is cooked once a week on Sundays.

More than 70 % mothers said they gave vegetables including GLV and 'dal' to their child when cooked with some increase in the percentage of this practice in the endline survey.

Consumption of Eggs by Families Who Set Up BYP

Table 2 shows that both the frequency and the weekly consumption of eggs showed marked increase in families who set up BYP. This suggests that this is a promising intervention for improving household food security.

Knowledge of Balanced Diet

When asked about the components of a balanced diet, almost all the mothers mentioned rice and vegetables including GLV in both the surveys. Also over 80 % mothers mentioned animal foods like eggs and meat initially and the number went up to over 95 % in the final survey. Initially, less than 50 % mothers mentioned foods such as 'roti' (dry salty pancakes made with wheat or millets), 'dal', fruits and milk. The percentage went up to over 90 % in the final survey. It was interesting to note that more mothers mentioned meat and eggs than 'dal' or 'roti' or milk in the initial survey.

Sanitation and Hygienic Practices

As mentioned earlier, safe drinking water and clean environment are very essential for nutrition security. In the KAP survey, 90 % mothers reported getting water from bore wells in the village or farms. Few families also got bottled water from reverse osmosis (RO) plants which are coming up in villages. Thus, in the villages surveyed, access to safe drinking water was there. However, problem area in sanitation is lack of bathrooms and toilets.

While 39 and 31 % households reported having bathrooms and toilets, respectively, in the initial survey, the number went up to little over 40 % in the final survey, suggesting that these are not perceived as priorities.

While all mothers said they washed hands before feeding the child, only 44 % washed hands with soap. That percentage went up to 94 % in the final survey. Not using

Table 2 Impact of backyard poultry with high egg-yielding breeds on weekly frequency and quantity of eggs consumption

Year	No. of units/initial and final survey		Consumption (g) per capita per week		Frequency per week	
			Mean	SD±	Mean	SD±
First year 2011–2012	38	Initial May 2012	2.22	1.202	2.32	0.739
		Final May 2013	3.27***	0.963	3.21***	0.905
Second year 2012–2013	60	Initial March 2013	1.79	0.668	1.78	0.666
		Final April 2014	4.88***	1.509	4.72***	0.940
Third year 2013–2014	52	Initial October, 2013	1.82	0.598	2.44	0.608
		Final May, 2014	4.16***	0.985	4.35***	0.617

*** $P < 0.001$, Asymp. Sig. (two-tailed) based on negative ranks, using Wilcoxon signed-rank test

soap to wash hands is a common observation which needs to be emphasised during education.

Knowledge of Cause and Management of Infectious Diseases

Except malaria where many women could name mosquitoes as causative agent, the understanding of the cause of common diseases like diarrhoea, typhoid, jaundice and tuberculosis was very poor. This was surprising since many women had studied beyond primary school. The knowledge of causes of diseases showed significant improvement in the end-line survey. It was interesting to find that even while the women did not know the cause of diarrhoea, 93 % mentioned ORS for treatment of diarrhoea. Salt sugar solution, 'sabudana' (sago) and 'gulab jamun' (an Indian sweet) were also mentioned for treatment. In the final survey, 'dal 'water was also mentioned.

Impact on Child Nutrition

Mean birth weight at the end of the first, second and third year as obtained from the records was 2.78 ± 0.374, 2.73 ± 0.438 and 2.81 ± 0.483, suggesting no change. Though only 9–12 % infants were born with low birth weight (<2.5 kg), 21–33 % had birth weight of exactly 2.5 kg suggesting at-risk status.

The growth chart (Fig. 1) shows data (weight for age) for all the 6- to 24-month-old children registered at the 'Anganwadi' centre from July 2011 (when the project was started) to July 2014 as obtained from the ICDS records. There was a significant reduction in the degree of moderate-to-severe malnutrition, over the 3-year period ($P < 01$-Lung Bopx test, ARIMA Model). The incidence of moderate-to-severe malnutrition varied from 41.5 % in September of 2011 to 20.2 % in March 2013. Figure 1 also shows seasonal effects on child nutrition. There was a trend of higher degree of moderate-to-severe malnutrition during the summer and monsoon months than during winter. This is a common observation due to greater morbidity during monsoon and relative scarcity of food, particularly vegetables during summer and early monsoon. Availability of foods, particularly vegetables, is best during winter.

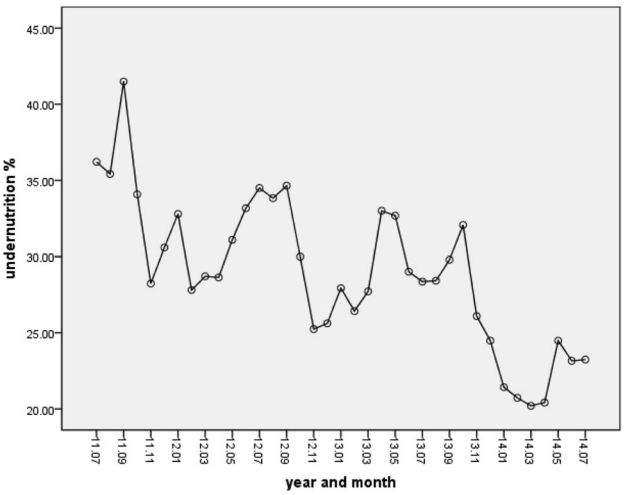

Fig. 1 Decline in moderate-to-severe nutrition deficiency as determined by the weight for age among the 6- to 24-month-old children, based on ICDS data, during the period of this study, July 2011–July 2014

Discussion

For nutrition security, there has to be awareness and access at affordable cost to age and physiological status-appropriate balanced diet, safe drinking water, disease-free environment and healthcare outreach. This would ensure the 4th A—absorption. Therefore, in this project, impact of multiple interventions combining education in health and nutrition with introduction of farm technologies like homestead gardens and BYP with high egg-yielding breeds was studied. The scope of education in this project was wider and included issues related to sanitation and health besides foods and nutrition. Improvement in mothers' knowledge and hopefully practice was remarkable stressing the importance of combining social engineering through education/communication to promote behavioural change with scientific and technological interventions. An informed mother is equipped to make wise choices, despite financial constraints. Despite stressing the importance of consuming home-grown vegetables at home, particularly by women and children, 50 % of the families sold 25–50 % of the vegetables grown in homestead gardens for economic reasons. This suggests that for nutrition security, ensuring livelihood and income are important.

Significant increase in the frequency of consumption of GLV, in the end-line survey compared to the initial survey, is a positive trend (Table 1). To some extent, consumption of other vegetables was replaced by GLV, perhaps because it was more attractive to sell the other vegetables in the market where the prices of vegetables were high.

Apart from homestead gardens and BYP, effort was also made to introduce millets like finger millet (ragi) and iron-fortified pearl millet (bajra) and motivate the families to grow more pulses. Orange-flesh sweet potato rich in β carotene was tested in few places. More effort to promote biofortified crops is needed. Organic methods of farming such as vermicomposting and use of botanical pesticides (decoction of chilli–garlic or neem seeds—*Azadirachta indica*) were also taught. More effort is also needed to promote judicious use of organic methods of farming which would protect environment and save money. Vermicompost units were set up by only 25 families.

Backyard poultry needs little investment in terms of money, space or feed (since these birds forage). Remarkable increase in egg consumption following setting up of small backyard poultry with high egg-yielding breeds suggests this to be a promising intervention. Few eggs that are produced are consumed at home, rather than sold, though some families did sell the eggs for hatching. Promising as this approach is to increase access to eggs—a highly nutritious food; its sustainability will depend on easy access to the good breeds of birds to replenish the old stock. Establishment of local poultry farms for breeding and supply of female birds would help. Alternately, all nondescript male birds should be removed from the village.

Since the target was women registered at the ICDS centres, impact on growth of 6- to 24-month-old children (the most vulnerable group) was studied from the growth charts maintained in ICDS centres. This would be an independent assessment, free of investigator bias. Improvement seen over the 3-year period is encouraging. It may be attributed to the education of the mothers since not all the families with 6- to 24-month-old children had set up gardens or poultry. The selected Anganwadi were well managed with motivated AW workers, who followed the schedule of weighing the children and took active interest in the project.

Champions of 'Food-based rather than Pharmacy-based' approach (to quote the eminent nutrition scientist Dr. C. Gopalan) for food and nutrition security look forward to learn from studies of this nature, though limited in scope. This has been the recent focus of FAO as well. The authors look forward to learn from a large study taken up in two states of India, by the MS Swaminathan Research Foundation, Chennai, to test a 'Farming System Model to Leverage Agriculture for Nutrition Security' mentioned earlier [2]. Even while food-based approach is important and empowering, for some nutrition deficiency disorders like iron-deficiency anaemia, pharmaceutical supplementation of vulnerable groups is necessary. Food fortification offers an important and effective method for combating micronutrient deficiencies. The success of iodised salt to combat iodine deficiency disease in India is a case in point. Double-fortified salt (iron fortified, iodised salt) has been developed in the country. Its efficacy has been shown. This salt needs to be promoted in a bigger way. Nutritionists differ on the continuation of massive dose vitamin A supplementation programme for preschool children. There is ample β-carotene in nature, and all effort should be made to promote food-based approach to combat vitamin A deficiency. However, this is a long-term strategy. In the mean time, vitamin A supplementation programme should continue since the current dietary intake of vitamin A and its precursors is very low [5]. Recently, Thompson and Amroso [9] have compiled experiences with respect to food-based approaches for combating and controlling micronutrient deficiencies. It brings out the benefits as well as limitations of such efforts.

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References

1. Bamji MS, Murty PVVS, Rao MV, Satyanarayana G (2011) Diversification from agriculture to nutritionally and environmentally promotive horticulture in a dry-land area. Sight Life 25:38–42
2. Das PK, Bhavani RV, Swaminathan MS (2014) A farming system model to leverage agriculture for nutritional outcomes. Agric Res 3:193–203
3. Iannoti L, Cunningham K, Ruel M (2009) Improving diet quality and micronutrient nutrition. In: Homestead food production in Bangladesh. IFPRI discussion paper 00928, prepared for the project on Millions fed: Proven Successes in Agriculture Development, November 2009, pp 1–44. www.IFPRI.org/millionsfed
4. Murty PVVS, Bamji MS, Rao MV, Prasad VLK (2013) Promotion of Backyard poultry for augmenting egg consumption in rural households. Ind J Nutr Diet 50:150–155
5. National Nutrition Monitoring Bureau (NNMB), technical report No. 26.2012. Diet and nutrition status of rural population, prevalence of hypertension & diabetes among adults and infant & young child feeding practices. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad
6. Ndaeyo NU (2009) Assessing the contributions of homestead farming to food security in a developing economy: a case study of Southern Nigeria. J Agric Soc Sci 3:11–16
7. Rahman FMM, Mortuza MGG, Rahman MT et al (2008) Food security through homestead vegetable production in the smallholder agricultural improvement project (SAIP) area. J Bangladesh Agric Univ 6:261–269
8. Talkukdar A, Haselow NJ, Osel AK et al (2010) Homestead food production model contributes to improved household food security and nutrition status of young children and women in poor populations. Field Actions Science Reports (online), Special issue 1-Urban Agriculture, Online since 17 February 2010, Connection on 13 June 2010. http//factsreports.revues.org/index404.html
9. Thompson B, Amoroso L (eds) (2011) Combating micronutrient deficiencies: food-based approach. FAO & CAB, Rome