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CASE REPORT

Sustainable Organic Food Chain in Mountainous Uttrakhand; A Case Study

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Abstract

The mountainous part of state Uttrakhand is known for the traditional integrated crop-livestock farming pattern, and unpolluted ecosystem. The cultivation of a few traditional and high-yielding varieties of fruits, grains, legumes, tubers, and vegetables is an example of sustainability. The production of plant-based food supplements and income by incorporating animal husbandry is an additional face of agro-ecosystem of the region. A similar food chain model supported by the technical expertise of current organic practices was studied in terms of strengths, weaknesses, opportunities and unpredictable natural calamities in the region. The indigenous knowledge and rich biodiversity, vast domestic markets of organic foods have lucrative business opportunities in the region, though, the availability of the basic network for sale of fresh produces, transportation, and simultaneous market demands are inter-connected, but not to be limiting in the future also. Organic practices are open to the entrepreneurial skill of farmers as a whole and secure positive ecological performance. The modern practices blended with indigenous knowledge have the potential to enhance the economic development of the region.

Keywords: Traditional Practices; Location Specific Crops; Market Demand; Sustainability and Opportunities

Introduction

Agriculture is a means of survival and a way of life, globally, linked to crop patterns and environmental quality. The utilization of renewable natural resources for agriculture has resulted in the development of organic agriculture, and the foodstuffs as 'organic foods' [1]. As per biotic and abiotic conditions a localized indigenous knowledge evolves for different crops [2]. The indigenous knowledge on agricultural practices has a great deal of relevance for productivity and sustainability, and helpful in developing low cost, location specific and appropriate technology for benefits of farmers [3,4].The core characteristics of the industrial revolution have significant implications in food quality and supply chains and affected the policies ensuing external costs. The primary producers have been locked into tight specifications and contracts, though consumers are benefited from cheaper food but enamored to quality and health externalities [5]. The indigenous agro-knowledge, skill and survival strategy of farmers have been ignored to overcome from low crop inputs [6].

Comparative studies on conventional vs. organic foods have revealed that organic foods have fewer nitrates and pesticide residues [7,8]. Meat from organically raised cattle, pigs and sheep have been reported to contain less total fats and saturated fatty acids but higher content of unsaturated fatty acids. [9]. Juices from organic spinach, welsh onion, and Chinese cabbage has been reported for 50-120% higher antioxidant activity than juices from conventionally produced vegetables [10]. The Antioxidant properties of currants grown organically have been reported 30% higher [9]. Compounds of therapeutic values such as quercetin, kaempferol, vitamin C, vitamin E, and phosphorus have been reported in higher concentration in organically grown foods compared to the conventional ones [11]. Fatty acids composition of milk from outdoor grazing, high biodiversity in pastures, low levels of concentrates and no silage feeding are more health beneficial. Organically produced milk compared to conventional have been reported to have more dry matter, calcium, vitamin C, less somatic cells, but more coliform bacteria [12]. Currently, the business of branded items have become more convenient due to advancements of information technology, use of the Laser Bar Codes (LBC) and Electronic Point of Sale (EPOS) systems in retailing have enhanced the credibility of the product as claimed, and customer-oriented approach [13]. It is difficult to develop the Unilever type market model, a single European Union, everywhere, like the late 1980s [14]. Commonly, a rural-urban-type society develops near the food production-site and customer travel to the production sites [14].

The Uttrakhand Himalaya is an important ecosystem, characterized by three different ecological zones; the lesser Himalayas (foot hills), Shivalik Himalayas (mid hills) and greater Himalayas (alpine hills) [15]. The flora and fauna are distinct in each of these

ecological zones. In lesser and Shivalik Himalayan regions human habitation is comparatively higher than high altitude Himalaya. The increasing dependence on natural resources for food, feed, and trade has resulted in a loss of fauna and flora, but now under control, due to foresee and identify the challenges and formulate prioritized research programs at the early stage [16]. The farmers in the hills of Uttrakhand are mostly marginal, practicing low external input based crops, but agriculture with animal husbandry, horticulture, live stock, and combined forestry provides opportunities for optimum utilization of the resources available in the region. As the hills of Uttrakhand are totally organic in itself and the soil has not been polluted [17]. The environment is clean and green with abundant biodiversity. The present agricultural system in hills of Uttrakhand may lead to the economic, green and sustainable path, as organic farming is gaining popularity [17]. It is supportive of the environment, health and sustainability. The unpolluted ecosystem and predominance of the traditional integrated crop-livestock farming pattern is additional support for organic farming in the region. Currently, there are a few certified organic farmers, promoting the organic farming and marketing of organic produces in the state [18]. In the present study, different organic food models were surveyed at different locations, documented and critically analyzed for SWOT (strengths, weaknesses, opportunities, and threats). The field level observations reveal that there is an abundance of organic manure, traditional livestock, and active efforts by the Govt., and non-Govt. agencies to promote the organic practices in mountainous Uttrakhand. Lack of natural sources of water on mountainous peaks and scanty knowledge for the future of organic foods among youths were a matter of concerned.

The entire state of Uttrakhand is rugged mountainous terrain except for district Udham Singh Nagar, Haridwar, Doon Valley, and parts of district Nainital. It accounts for 1.61 percent of the total geographical area and 0.82 percent of the total population of the country [19]. The region (both the Kumaun and Garhwal Himalaya-Uttrakhand) is rich in scenic beauty and natural resources [20]. Tourism, an ethic based socio-cultural network along organic food practices the state has enormous power for economic development. The topographical, infrastructural and environmental constraints have been almost managed in the state and the open door type situation is there for proper utilization of natural resources available in the region, though a few natural calamities also. To achieve the target, various agencies are actively working together. In the present study (February 2017 to April 2017) sustainable food chain models developed by HESCO (Himalayan Environmental Studies and Conservation Organization)-Dehradun (a non-Govt. organization) and Govt. institutions were selected. The broad objectives of the study were; (i) Himalayan bioresources vis-à-vis research activities for sustainable utilization, and (ii). Technology dissemination and outreach programs. The specific objective of the study was to find an inter-relationship (scientific and technological) with the Northeast Himalayan region of the country to share the organic food practices in the future.

Materials and Methods

Present study was focused on the outcome research activities and technology dissemination by research organizations in Uttrakhand for sustainable utilization of bioresources. The research plan was designed on the explanatory sequential mixed method approach to collect data and integrate for quantitative and qualitative analysis [21]. Sequential mixed method approach was followed for explanatory tasks, in particular, first conducts quantitative research, then uses qualitative research to explain the quantitative results in detail [21]. To understand the cultural values six elements model (aesthetic, spiritual, social, historical, symbolic, and authenticity) was adopted [22]. Aesthetic values were to the visual beauty of farmland and agriculture-related elements, spiritual values were for religious traditions, social values were for relationship between agricultural landscape and cultural identity, historical values were to connect the past, symbolic value was for portrays agriculture sites as repositories of meaning, and finally, authenticity for 'quality of real feeling', not contrived. After analyzing the data according to these elements, a SWOT (strength, weakness, opportunity, and threat) analysis was adopted to highlight strong and weak points, opportunities and threats, a starting point to imagine the potential for a sustainable future [23].

During the survey, various research organizations, experimental facilities, work-stations, and extension centers working on Himalayan bioresources in Uttrakhand were visited personally, interacted with each concerned, explained the objectives and specific objectives of the project. After kind permission laboratory/-field/-workplaces were visited, discussed with executives, technical and floor-staffs with prior permission from the concerned authorities, and individuals, respectively. The points discussed and information gathered was immediately noted. The discussion was mainly focused on uniqueness at the workplace, previous work experience, difficulties realized to perform the current job, if any, as well as the possibilities of improvement, and future scope, including career-oriented activities e.g. training, workshop/-seminars, etc. to improve the quality of service. The site-view was photographed with prior permission of the authorities. At DARL (Defence Research Agricultural Laboratory-Pithoragarh), photography was not done. During field visit, two cases related to Goat husbandry could not be photographed as animals were set free for grazing early morning to till evening, so the only discussion with the family head was possible, and immediately documented. Whenever, wherever signals available, GPS data were documented, as bad weather was the main concern.

Results and Discussion: Organic food chain- the Amma Bhojnalaya, Rudra Prayag

'Community awareness and sustainable livelihood program'

About 75% of the total population of Uttrakhand is dependent on agriculture [24]. Various locations of Garhwal Himalaya (district Dehradun, Tehri Garhwal, Rudra-Prayag, and Chamoli, respectively) were found conducting the 'community awareness and sustainable livelihood programs' in Uttrakhand, during field survey under the technical supervision of HESCO-Dehradun.

Additionally, it was informed that similar programs are in-progress in Kumaun Himalaya also by the technical staff and executives of HESCO-Dehradun. HESCO-Dehradun was providing the certified seeds, recommended to grow at the selected agro-geo-climatic conditions of the region of vegetables (spinach cauliflowers, cabbage, potato, etc.), spices (garlic, onion, coriander, etc.), and grain crops (gram, pea, wheat, etc.) along the technical services. Time to time fields visit by HESCO-Dehradun technical persons to help farmers were the salient features of the program as informed by field-workers and supported by documents. There was a provision to deposit the same quantity of seeds in 'Farmer Bank' (Kishan Bank) at the end of harvest for each farmer. These seeds were to be re-issued to farmers joining as new members to the program to the next year to maintain the sustainable chain in future also (Figure 1 and 2).

Figure 1: Village Khetu (Taheri Garwal)

Figure 2: 'Kishan Bank' at Village Khetu

Fauna and flora restoration by means of water conservation

In recent years the crop diversity of the Uttrakhand Himalaya has declined to an alarming proportion. Many factors are responsible for the sudden decline of cropping pattern viz. change in food habits, loss of biodiversity and natural resources, low grain productivity and replacement of traditional cropping system [25]. The major challenge according to all respondents was unpredictable droughts in the region, a major issue leading to the loss of entire crops, and there was one voice for more help from agencies for maximum utilization of rainwater (conservation, and harvest, respectively), though there was water supply to the scattered houses in villages through community water tank, mainly on peaks of mountains. These water supply chains were found on working conditions and also acknowledged by all respondents positively. Farmers were irrigating their kitchen gardens, as well as the terrace fields. These activities were observed at village Khetu (Tehri Garhwal) and Sahshradhara (Dehradun) of the state (Figure 3 and 4).

Figure 3: Artificial Water Pond at Khetu

Figure 4: Community Water Tank at Khetu

Water Mills (Gharats)

Use of water for mechanical energy to food processing is associated with the local cultures of mountainous Uttrakhand [26]. During the discussion, all respondents had preferred use of flour by Water Mills (Gharats) and acknowledged the taste and health benefits of it. The traditional Water Mills to grind wheat grains to flour, millets, etc. were observed at operating conditions with modern techno-approach, working under the technical supervision of HESCO-Dehradun. The traditional timber feather-like structure was replaced by metallic fans, erected on the iron base, which was capable to rotate the stone mill even at the minimum flow of water during the winter season (Himalayan water sources get charged during summer due to snow melting). During the month of February the Water Mill caretaker, at village-Dokwala informed to grind 150 Kg wheat grains in 12 hours @ Rs. 1.00/ Kg, while it was Rs. 2.50/Kg at Electric Mills (Figure 5 and 6).

Figure 5: Water Mill at Village Dokwala

Figure 6: Water Mill at Bagda Dhoran Gauv

Horticulture activities

Uttrakhand is known for its mixed farming that includes dairying, horticulture, agroforestry and organic farming [27]. During field visit there were universal or near-universal agreements among farmers that organic farming is better for the environment and soil health, and organic produces were believed to be healthier than conventional one, though a few young farmers were also concerned on the less yield by organic means, all respondents were also aware of the health risk posed by pesticides to their own health, if used for food items. Farmers had planted the saplings or seeds to grow the quality horticulture plants (malta, walnut, orange, etc.) observed at Sera Gauv and village; Ghat Chatti (near Joshi Math). There was a training-cum-demonstration center to educate the rural youth and entrepreneurs to produce the value-added products from fruits produced locally, e.g. Malta juice, Buras juice, different pickles, etc., at Govind Ghat (Joshi Math). The villagers were trained on a volunteer basis by the HESCO-Dehradun as informed and observed during the discussion with trainees. Plantation of the walnut tree, malta, and pear, etc. were seen in many places during the field visit along the roadside villages also (Figure 7, 8, 9 and 10).

Figure 7: Sera Gauv

Figure 8: Ghat Chatti, Malta saplings

Figure 9: Ghat Chatti, Malta Tree

Figure 10: HESCO Centre, Govind Ghat

Poultry

Historically, during the earlier days in Uttrakhandbirds were reared in rural household's backyard were often referred to as 'desi birds' (indigenous birds) which have their own distinctive features and demand. This traditional poultry in the recent past has been recognized as a potential home-based enterprise as a small backyard poultry enterprise [28]. There were many success stories related to developing the poultry as the cottage industry under the local supervision of HESCO. Mrs. Bhagwati Devi Govind Ghat had informed that the poultry program is technically supported by HESCO-Dehradun, and acknowledged her association with the program for the last three years. Further, Ms. Bhagwati Devi revealed that she is selling per egg at Rs. 10.00 at home, after everyday home requirement. On the question of causes of a higher price than the market, she stressed to look at the quality and properties of the product and concluded that it is self-explanatory. The scheme was also based on a sustainable chain concept to give the bird to the new joining person without cost, equal to receive in beginning. Mrs. Bhagwati Devi has earned more than Rs. 6000/- profit till the date, as informed by her during the discussion. She was looking to grow the business, as the sale of poultry products was no issue to her as customers were abundant at home, as she informed (Figure 11 and 12).

Figure 11: At Govind Ghat

Figure 12: Net House for Poultry

Community health awareness and support

Marginal communities in far rural Uttrakhand have suffered from dual problems of (i). Poverty, and (ii). Common health-related ailments [29]. Different organizations had identified the problem in Uttrakhand long-back and started for poverty alteration by encouraging health awareness by various means including the govt. support. Women were the most sufferers due to smoke during meal preparation using wood as fuel. The smokeless furnace (wood-choula) is innovation, is highly helpful to improve the working condition during cooking in marginal rural communities. In 2013 natural calamity-hit areas of state Uttrakhand, and re-habited families in low-cost affordable houses, there was a 'smokeless wood furnace' (wood choula) was designed to passes-out entire smoke through a chimney. A similar case was documented from the village Jelly, Mr. Gan Singh Rana (M: 9837409179, P.O.: Umdisamli, Rudra Prayag), was a beneficiary of the scheme. It was informed that a villager Mr. Sanjeev Singh Pawar (M: 9627632784) resident of village Jelly has technical expertise in designing the smokeless wood choula. It was also claimed by Mr. Pawar that he has

installed more than 40 such choulas, in presence of HESCO delegate, Mr. Raghubir Khandwal (Mobile no.; 9411125688) during the field visit (Figure 13).

Figure 13: Smokeless wood furnace and a low cost affordable house; Village, Jelly (Rudra Prayag)

Poly-houses for yearlong availability and low-cost food items

Indigenous vegetables and pulses are the primary food of Uttrakhand. Maize, millets, and wheat are the staple foods, the distinctive character of the region [24]. During the field survey, Bunda, a village of 25 families, each with a poly-house was earning good revenue by selling vegetables/-saplings after family needs, even in offseason also. 'Chetna Gram Krishak Samiti Ayarchauri', chairman, Mr. Mahabir Singh Bartwal (M: 9410723918), Village Budna, Rudra-Prayag informed that total village boundary land has wire fencing (940 M), to prevent wild animals, the total cost of Rs. 3,91,000/- + self-volunteer labor. Similar trends for different purposes were observed at Ghat Chatti and Vinayak Chatti, locally supervised by HESCO-Dehradun, funded by different govt. agencies (Figure 14 and 15).

Figure 14: Village Budna (Rudra Prayag)

Figure 15: Wire-fenced village boundary

Look for a secondary home of high-value crops

Figure 16: Saffron field (1380 MSL)

Saffron (*Crocus sativus*), the most expensive spice in the world is propagated vegetatively. There is a need to expend the area under its cultivation to meet the increasing demand [30]. During field studies under the aegis of HESCO-Dehradun saffron cultivation at 1380 M. altitude (N 30°28'48", E 78°98'44") by Mr. Laxman Singh Sajwan (Mobile no.: 8979158811), village - Medanpur, district-Rudra Prayag was observed. He was using the saffron in a local preparation of Jigora (*Echinochloa frumentacea*) Kheer. The look for secondary niche is a highly scientific approach as the *Capsicum annuun*, a crop of North American native, reached in India from Europe and Africa, today has 36% of global production alone in India [31]. It is a story of success of secondary home for commercial cultivation of the plant species, though very rare (Figure 16) [32].

Low-cost bridge during natural calamity

The Himalayan geography and climate are non-predictable, natural calamities such as cloud blast and landslides are a common phenomenon in the region [15]. The low-cost bridge technology, developed by DRDO, was observed as a successful and timely utilized technology that surface-out in 2½ days during 2013 natural calamity in a seasonal river basin in Rudra Prayag, at remote but a connecting link for many villages [33]. At least a minimum 200 villagers were daily passing through it, as per discussion with locals. The communities of these barren hills, where land is stone dominated, and it is difficult to cultivate grain crops, and other requirements such as health, education, selling of dairy products, are linked to towns, except cattle care, knowledge to build such a bridge in a short time is highly helpful at the time of natural calamities (Figure 17).

Figure 17: Low Cost Bridge

Amma Bhojnalaya (Grand Mother Restaurant)

The organic food products from the aforesaid locations along non-documented herewith were mostly used at the 'Amma Bhojnalaya' (Grand Ma Restaurant), which was partially sponsored by the state government, as informed. The grains, vegetables, and spices all locally cultivated by means of organic practices were cooked in a restaurant (i.e. Amma Bhojnalaya) for which room, electricity, and water was provided by the state government without any cost, only fuel price and salary of workers were to be paid by the concerned. Everyday average 100-200 customers, @ Rs. 25/-, per plate food, were served to the customers without any differences. Every food ingredient in the preparation used was claimed from the organic practices. Jigora (*E. frumentacea*) Kheer was an additional menu, totally organic product, @ Rs. 10/- per cup. Saffron, (*C. sativus*) an essential ingredient of the Jigora Kheer was also grown organically, the cultivation on the field was also verified by the author himself. Mr. Laxman Singh Sajwan (M; 8979158811), a resident of village-Medanpur, Rudra Prayag was looking at the activities of the organization.

Daily awareness by local Radio broadcast

The state government policies were observed as friendly and helpful to promote organic food practices in the state. Mr. Raghubir Khandwal, HESCO-Dehradun representative has organized a visit to local Community Radio Station at Rudra-Prayag to the author, a center used for technology dissemination and the daily update to all people of the region in the local language. It was covering Districts Rudra Prayag, Tehri Garhwal, Podi Garhwal, and Chamoli, using 90.8 MG, 50W Transmitter, named; 'Mandakini Ki Awaj', broadcasting in the local language (7.00 am to 6.30 pm, daily) by various programs for improving the livelihood of the people. The programs were mainly focused on technology dissemination, the new innovation related to traditional knowledge, various programs conducted by govt. depts., survey, visit, the addition of folklore with technology dissemination and discussion with technical experts (medical doctors, learned teachers, social workers, and professionals e.g. agriculture, veterinary, metrological experts, etc). Mr. Manvendra Negi (M; 9639649971, 9837095433, e-mail; radiomandakini@gmail.com) was the Station In-charge for the center (Figure 18).

Figure 18: A local Radio Station; 'Mandakini Ki Awaj' – Rudra Prayag

Conclusion

Farmers of the mountainous Uttrakhand have been practicing agriculture by indigenous methods which are of great significance in conserving the environment and sustainability of the agricultural production system [34]. The present system is not enough to meet the market's requirements. A commercial level organic cultivation in remote rural locations has marketing difficulties, but sustainable due to mixed agro-economy. The location-specific cultivation with modern agro-practices are to be introduced on field trials before the large-scale cultivation, as locations near the metros of Uttrakhand it-self, and neighboring states (Delhi, Uttar Pradesh, and Punjab) have adopted a similar trend presently [35].

Up-gradation of the basic facilities

The economic development is dependent on the infrastructural facilities like roads, power, availability of water, and communication. It is essential to study the basic infrastructural network in the regions as roads, power, communication, natural water sources etc. [36]. There is a need for result oriented programs to promote organic food practices especially villages at mountainous peaks.

Resources and utilization

Horticulture, major sectors in the economy of the state, has an opportunity for diversification and increased employment in the region at many folds [37]. The conventional agriculture is to be substituted by horticulture where the scope of a high rate of growth is rather limited due to peculiar topography, an effective tool for boosting the income of farmers. The region has been observed as endowed with a mixed variety, and huge livestock population, but with low productivity [38].

Beekeeping (NBB, 2018) and sericulture have an excellent opportunity as the region is rich in natural vegetation, and agro-climatic conditions are suitable [13,39]. Large numbers of water bodies comprise of fast flowing rivers and their tributaries, high and low altitude natural lakes, ponds and doggies are an excellent source of fishery resources in the region. The favorable ecology of the region to develop commercial fishery ponds has the enormous potential of employment and business.

There is a need to establish agro-processing facilities close to the points of specific crop production zones to promote off-farm employment [40-45]. Though there are means of communication in local dialect in radio and television programs, frequency to discuss the sustainable organic food chain and economic development of the region is to be enhanced for more awareness generation.

Rise in health issues from contaminated food, and issue rose by different regulatory agencies, globally, the food productivity and its higher quality are under debate. Efforts by different programs to promote the cultivation of quality organic foods are the need of the hour. The diversified agriculture mix of animal husbandry including poultry, fishing, beekeeping, etc. are available options for sustainable employment. During the survey, customers oriented organic food market pattern was observed.

The results of the present study highlight for more research and additional action plans to interlink the scattered organic food units into a chain as 'Amma Bhojnalaya', to strengthen the organic practices in the state and regions wherever the similar agro-practices are followed.

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