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Vegetable Cultivation in Mizoram: Status, Issues and Sustainable Approaches

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ABSTRACT

The terrains of Lushai hills (Mizoram) are endowed with rich genetic bio-diversity of various vegetables (*Sechium edule*, *Cucurbita moschata*, *Benincasa hispida*, *Cucumis sativus*, *Momordica* spp., *Trichosanthes* spp., *Phaseolus vulgaris*, *Vigna unguiculata*, *Dolichus purpureous*, *Vigna umbellata*, *Parkia roxburghii*, *Psophocarpous tetragonolobus, Brassica juncea* var. *rugosa*, *Brassica oleracea* var. *alboglabra*, *Cyphomandra betacea*, *Zingiber officinale*, *Curcuma* spp., *Colocasia* spp., *Solanum melongena*, *Solanum gilo*, *Solanum macrocarpon*, *Capsicum annum*, *Capsicum frutescens* and *Capsicum chinense*) which could be used to improve yield potential, quality and tolerance to stresses. Moreover, the use of hybrids/ high yielding varieties, access to knowledge and technologies, interactive demonstrations, better input delivery systems, good communication, and proper utilization of available resources would be very useful in enhancing the vegetables' productivity, and ensuring the food and nutritional security to the tribal community.

Keywords: Vegetable, Spices, Genetic diversity, Mizoram

INTRODUCTION

Vegetable crops are edible herbaceous, viny, shrubby or tree in growth habitats, but usually succulent plant, eaten with staples as main course or as supplementary food either in cooked, semi-cooked or raw form. Vegetables improve nutrition (being good source of vitamins, minerals, antioxidants, nutraceuticals, carbohydrate, protein and fiber), possess some medicinal values, generate employment, increase income, provide business opportunities and have export potential; and finally "prosperity for the poor and health for all" by providing food, nutrition and income security.

Mizoram, comprising of nine districts, is 23rd state of India located at 21º58´ to 23º35´ N latitude and 92º15´ to 93º29´ E longitude and surrounded by Tripura, Assam and Manipur in north frontier regions; Bangladesh in west; and Myanmar in east and south. The undulated topography of Mizoram, named as Lushai hills during British period, has varied altitudes ranging from 21 to 2157 m above the mean sea level with an annual rainfall of 2000-3200 mm. In summer (Monsoon), mean monthly temperature ranges from 14.6ºC to 29.6ºC, while during winter minimum temperature falls up to 11.8ºC. Soils, in general, are sandy loam to loam and loam-clay to clay, rich in humus, acidic (4.5-6.5 pH), and medium in phosphorus and potash content. The total geographical area of Mizoram is about 21087 km^2, of which net sown area constitutes only 4.4 %. The ever increasing population pressure has brought down the jhum cycle and low soil fertility due to degradation of soil and natural resources, heavy rainfall and poor nutrient recycling. The terrain of Lushai hills is characterized by inaccessibility, marginality, fragility, ethnicity, rich bio-diversity and low crop productivity in general. The agricultural land in Mizoram is comprised of slopy upland (jhum/ shifting cultivation) and low land of valley (settled agriculture). Moreover, jhum cultivation is considered as major source of rural economy and a part of cultural requirement. In general, the upland and low lands are under traditional system of cultivation without any improved input technologies. Mizoram is producing 206314 t of vegetables including tuber crops and spices from

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12195 ha area with a productivity of 16.9 t/ ha. In a unique system 'The Shop without a Keeper' (Nghahloh Dawr in Mizo), one of the rarest traditional barter systems, is still in practice even today. In this system one can shop by himself at a guard less roadside store and then drop the money into a box and walk away. One can buy some fresh vegetables, fruits or eggs at various places 'Nghahloh Dawr' along the route between Seling to Keifang villages in Mizoram.

PRESENT STATUS

Vegetable cultivation in Mizoram

The vegetable crops with their Mizo name (in parentheses) which are being grown and consumed to a considerable extent are cabbage (Zikhlum), chow-chow (Iskut), chilli (Hmarcha), ginger (Sawhthieng), turmeric (Aieng), French bean (Bean), Chinese/ vegetable mustard (Antam), Chinese kale (Fren antam), potato (Alu), cowpea (Behlawi), Indian bean (Bepui), brinjal (Bawkbawn), African egg plant (Satinrem), *Solanum gilo* (Samtawk and samtawkte), tomato (Tomoto), tree tomato (Thing or Shillong tomoto), tree bean (Zawngtha), *Allium fistulosum* (Mizopurun), okra (Bawrhsaiabe), Burmese coriander (Pardi), pumpkin (Mai), kakrol (Maitamtok), snake gourd (Berul), wax gourd (Maipawl), cucumber (Fanghma), ridge gourd (Awmpawng), bitter gourd (Changkha), bottle gourd (Umei), muskmelon (Hmazil), water melon (Dawnfawh), carrot, radish (Buluih), tapioca (Pangbal), colocasia (Bal), cauliflower (Parbawr), knol-khol (Bulbawk), garden pea (Motor chana), sweet potato (Kawl bahra), yam (Bahra), pigeon pea (Behliang), rice bean (Bete), soybean (Bekang), water mimosa (Dum zawngtah), subabul (Japan zawngtah), Indian fern (Chakawk), various bamboo species (rawte, rawthing, talan, vairua, phar, phulrua, rawlak, rawnal, rawmi, rawpui, tursing, mautak, chal, saiman, rawngal, rawthla, lik and ankua), etc. Apart from human food, these vegetable crops have the potential for processing industry for value addition, and also by-products provide feed to pig, poultry, cattle and fish. The diverse agro climatic conditions (humid temperate sub-alpine zone, humid sub-tropical hill zone and humid mild-tropical zone), varied soil type, and abundance of rainfall offer immense scope for cultivation and conservation of different types of vegetable crops.

In Mizoram, the commercial cultivations of vegetable crops are practiced only in few pockets such as Sihphir, Seling and Sateek in Aizawl district; Buhchangphai and Saihapui in Kolasib district; Dintharveng and Kyonzar in Khazawl district; Hnalan and Ramthalang in Champhai district; and peri-town area of Lunglei, Lawngtlai and Saiha districts. The area, production and productivity of leading vegetables including tuber crops and spices being grown in Mizoram are given in Table 1.

Table 1: Status of vegetable area, production and productivity in Mizoram (2007-08)

Vegetable crops	Area (ha)	Production (t)	Productivity (t/ ha)
Chow-chow	714	26418	37.0
Cabbage	200	5000	25.0
Tomato	17	298	17.5
Brinjal	80	100351	16.9
Pea	139	462	3.3
French bean	167	470	2.8
Radish	37	181	4.9
Carrot	45	950	21.1
Cauliflower	30	438	14.6
Knol-khol	52	698	13.4
Chinese cabbage	167	803	4.8
Broccoli	36	385	10.7
Cucumber	91	802	8.8
Okra	92	540	5.9
Cowpea	107	718	6.7
Pumpkin	103	1533	14.9
Bitter gourd	76	996	13.1
Snake gourd	64	1149	18.0
Bottle gourd	26	531	20.4
Ash gourd	90	2408	26.8
Water melon	91	1799	19.8
Musk melon	29	450	15.5
Rice bean	15	100	6.7
Samtawk	58	273	4.7
Potato	1688	15960	9.5
Other tubers	119	890	7.5
Turmeric	4175	8350	20.0
Ginger	3587	57011	15.9
Bird eye chilli	100	200	2.0
Total	12195	206314	16.9

Anonymous (2008)

Bio-diversity of vegetable crops in Mizoram

The terrain of Lushai hills is well known for its rich genetic resources and variability for various types of cucurbitaceous vegetables such as chow-chow (*Sechium edule*), pumpkin (*Cucurbita moschata*), wax gourd (*Benincasa hispida*),

cucumber (*Cucumis sativus*), sweet gourd or kheksa or kakrol (*Momordica cochichinensis*), kartoli or spine gourd (*M. dioca*) and snake gourd (*Trichosanthes cucumerina* and *T. anguina*). The region also abounds with leguminous vegetables like French bean (*Phaseolus vulgaris*), cowpea (*Vigna unguiculata* cv.gr. *sesquipedalis* and *V. unguiculata* cv. gr. *unguiculata*), Indian bean (*Dolichus purpureous*), rice bean (*Vigna umbellata*), tree bean (*Parkia roxburghii*) and winged bean (*Psophocarpous tetragonolobus*). Tree bean is one of the most useful multipurpose tree species found in Mizoram. Morphological variants of Chinese/ vegetable mustard (*Brassica juncea* var. *rugosa*) and Chinese kale (*Brassica oleracea* var. *alboglabra*), and tree tomato (*Cyphomandra betacea*) are also available on tribal community's domain. Tree tomato is a perennial shrub producing egg shaped, reddish-yellow colour and smooth skinned fruits of 30-50 g weight. Among the root/ rhizomatous vegetables, sufficient diversity is available in ginger (*Zingiber officinale*), turmeric and related species (*Curcuma longa, C. amada, C.* spp.), colocasia (*Colocasia* spp.), tapioca (*Manihot esculenta*), etc. Rich bio-diversity is also available for *Abelmoschus* species. A local cultivar of *Abelmoschus esculentus* having 7-9 stigmas instead of 6-7 in general are also in cultivation among rural populations. Among the solanaceous vegetables, the genetic variants of brinjal (*Solanum melongena*) are widely distributed all around of Lushai hills. In addition to cultivated brinjal, two variants of *S. gilo* having green, purple and creamish-white colour fruits at physiological maturity which turns red on ripening (Samtawk) and small green fruited (samtawkte) are found in abundance. The young leaves of African egg plant (*Solanum macrocarpon*) are usually cooked and used in curry, boil, meat and soup, and could be used as a genetic resource for improving agronomic traits of brinjal. Besides *Solanum* species, chilli groups offer a greater extent of heritable genetic variability among common chilli (*Capsicum annum*), bird eye chilli (*C. frutescens*), world's hottest chilli, i.e. King chilli (*Capsicum chinense*), dulle chilli and many more (Asati and Yadav 2004, Singh et al. 2010b, Singh et al. 2011d, Singh et al. 2013, Yadav et al. 2005 and Yadav et al. 2009).

Constraints of vegetable cultivation

Although the area is blessed with dense forest and shrubs, rich bio-diversity and good weather conditions; yet productivity of various vegetables are too low due to following reasons as follows:

- Jhum cultivation is still the preferred cultivation practice.
- Poor water-harvesting structures and almost no irrigation facilities.
- Mono-cropping.
- Lack of awareness for productive and efficient inputs.
- Cultivation devoid of good agricultural practices (GAP).
- Minimum use of biological, physical and chemical inputs.
- Inadequate input delivery systems.
- Poor basic communication infrastructures like roads, transport, market, etc.
- Inadequate post harvest management and processing technologies.
- High incidence of pest and diseases especially during summer-rainy season, i.e. with onset of rain to its recession (April to October).
- Unawareness of off-season and high-tech production technologies.
- Inexperienced human resources and poor research infrastructures.

FUTURE STRATEGIES

Over the years, the tribal farming communities have been using many indigenous technologies to fulfill their vegetable requirements by utilizing the available resources from jhum lands. They were depending entirely on locally available input resources and knowledge base for maintaining the productivity. But due to time factor, changing climate and system responsiveness to varying requirements of ever increasing population; there are needs to intervene the jhum practices and traditional cultivation to increase the land productivity and fertility sustainably, and also to meet the self-reliance in vegetable demand (Singh et al. 2010a, Singh et al. 2010c, Singh et al. 2011a, Singh et al. 2011b, Singh et al. 2011c, Singh et al. 2011e and Singh et al. 2012). Therefore, strategies formulated for meeting the demand and need of vegetable production, the planners should address two major issues: firstly, a sustainable vegetable production plan and secondly, livelihood enhancement opportunities. Hence, the segments which require immediate steps are as mentioned hereafter point by point:

Introduction of high yielding varieties and hybrids

One of the most important and basic requirements for higher productivity is adoption of high yielding varieties/ hybrids and accessibility of quality seeds to the farmers. ICAR Research Complex, Kolasib, and KVKs are main agencies in the state for varietal trial. The few varieties which performed better at ICAR Research Complex, Kolasib, Mizoram are as follows (Table 2):

Plant population and crop geometry

It is very important to maintain the proper plant population and crop geometry to harness the complete synergy of sun-light, nutrition and water

Table 2: High yielding varieties and hybrids of various vegetable crops

Vegetables	Varieties/ cultivars	Hybrids
Cabbage	Pusa Ageti, Golden Acre, Pride of India and Pusa Mukta	KGMR-1, Blue Diamond, Harnil, Bahar, Pragati, Green Express, Green Challenger, Kaveri, Quisto, Fieldman, Green Ball and Ryozeki
Knol-khol	Early Vienna, White Vienna and Late Vienna	INDAM Early Vienna
Cauliflower	Pusa Subhra, Pusa Snowball K-1, Pusa Himjyoti and Meghalaya Local	Pusa Synthetic, Pusa Hybrid-2, Deepa, Asmita, Suhashini, Mahima and Himani
Broccoli	Pusa Broccoli KTS-1	Pushpa, Aishwarya, Fiesta and Harumi-188
Brinjal	Pusa Purple Long, Pusa Purple Cluster, KT-4, Pant Samrat, Pant Rituraj, Pusa Bhairav, Arka Kushumakar, Arka Sheel, Arka Shirish, Pusa Kranti, Megha Brinjal-1, Megha Brinjal-2 and Megha Brinjal-3	Pusa Hybrid-5, Pusa Hybrid-6, and NDBH-1
Chilli	Pusa Jwala, K-2, Pusa Sadabahar, Arka Lohit, King chilli, Mizo chilli (Bird eye chilli), Dulle chilli and Pant C-1	Agni, CH-1, BSS-782, Mahima and Tejashwini
Tomato	Pusa Ruby, Pusa Gaurav, Pusa Rohini, Sioux, Arka Abha, Arka Saurabh, Arka Alok, Sel-1, Sel-2, Sel-3, Pusa 120 and Punjab Chhuhara	Avinash-2, Pusa Divya, Rocky, INDAM-100, INDAM-1116, Pusa Hybrid-2, Vaishali, Rupali, Mahavir, BSS-3000, TO-017, Arvind, TO-1458, NP-169 and Rita
French bean	Arka Komal, Kentucky Wonder, Canadian Wonder, Sel-60 (Nagaland), Sel-43 (Silchar), Sel-35 (Meghalaya), Sel-37 (Meghalaya), Sel-19 (Manipur), Sel-33 (Arunachal Pradesh) and Mizoram locals such as MZFB-27, MZFB-30, MZFB-40, MZFB-48, MZFB-44, MZFB-32, MZFB-38, MZFB-29, MZFB-51 and MZFB-47	-
Cowpea	Yard Long Bean, Pusa Komal, Mizoram locals such as MZCP-9, MZCP-10 and MZCP-11	-
Indian bean	Pusa Early Prolific and Local	
Garden pea	Arkel, Bonneville, Arka Ajit, Lincoln, PM-2 and VL-3	-
Carrot	Pusa Yamadagni, Nantes, Pusa Kesar, Pusa Meghali and Meghalaya Local	Hybrid-1
Capsicum	California Wonder and Pusa Deepti	Swarna, KT-1, Bharat, Mahabharat and INDAM-7207
Okra	Parbhani Kranti, Arka Anamika, Arka Abhay, Pusa A-4, Pusa Makhmali, Punjab Padmini and VRO-6	Varsha Uphar, NS-801, NS-818, NS-810, Okra-151, NOL-303, NOL-101, OH-597 and Green Challenger
Cucumber	Poinsett, Japanese Long Green and Mizoram Local	Pusa Sanyog
Radish	Japanese White, Pusa Himani and Meghalaya Local	-
Ginger	Nadia, Thingaria, Thinglaidum, Thingpui, Basar Local and Meghalaya Local	-
Turmeric	RCT-1 (Megha Turmeric-1), Lakadong, IISR Allepy Supreme, IISR Pratibha, IISR Kedaram, Roma, Rasmi, Suranjana and Duggirala	-

Mizoram Local: These are the local land races collected from Mizo farmers and evaluated at ICAR Kolasib, Mizoram.

for maximizing the yield per unit area per unit time as well as to minimize the plant-weed competition. The time of sowing/ planting/ transplanting, seed rate and spacing of various vegetables are as follows (Table 3):

Integrated water management

Mizoram is blessed with good rainfall to the tune of 200-320 cm annually which is mainly distributed from April to October and there is a lot of water scarcity being faced by whole of the state from November to March, peak period of winter season vegetable cultivation. Following the mentioned practices would help in reducing the water scarcity efficiently and also will enhance the water use efficiency and vegetable productivity.

- Water-harvesting and construction of Jal-Kund (Water storing structure).
- Mulching with locally available grasses, crop residues, forest shrubs, etc during dry period.
- Drip irrigation

Integrated nutrient management (INM)

A live healthy soil with proper cropping patterns, crop residue management (Vermicomposting, green manuring, etc.), application of organic manures and bio-fertilizers, effective crop rotation, and judicious use of chemical fertilizers can sustain optimum productivity over the years. INM includes a comprehensive management approach and addition of plant nutrients through all sources to improve soil health and ecosystem of the region, and thereby productivity and quality of produce. To promote the INM and organic farming in Mizoram, the ICAR Research Complex, Kolasib supplied more than 6000 kg of vermiculture to the State Govt., Growers' Association and farmers of Mizoram during 2008-2010.

Integrated pest management (IPM)

It is the integration of all the practices to manage the diseases and pests effectively without any loss to crop production, soil, environment and

Table 3: Time of sowing/ planting/ transplanting, seed rate and spacing of vegetables

Vegetables	Time of sowing/ planting/ transplanting	Seed rate (per ha)	Spacing (cm)	
			Row to row	Plant to plant
Cabbage	November	400-500 g	40-50	40-50
Knol-khol	November	0.8-1.0 kg	40-45	40-45
Cauliflower	November	400-500 g	40-50	40-50
Broccoli	November	400-500 g	40-45	40-45
Brinjal	April-May September	350-500 g	50-60	50-60
Chilli	April-May	1-1.5 kg	50-60	40-50
Tomato	November	300-400 g (V) 125-175 g (H)	50-60	40-50
Chinese kale and vegetable mustard	October-November	1.5-2.0 kg	40-45	25-30
French bean	April-May & October (Pole type)	25-30 kg	100-125	80-100
	November (Bush type)	80-90 kg	45-60	10-15
Cowpea	April-May (Pole type)	15-20 kg	100-125	80-100
	November (Bush type)	40-50 kg	45-60	10-15
Indian bean	April-May	8-10 kg	200-250	125-150
Garden pea	October-November	80-100 kg	30-45	8-10
Carrot	November	5.0-6.0 kg	25-30	8-10
Capsicum	November	500-600 g (V)		
300-400 g (H)	50-60	40-50		
Okra	April	8-.0-10.0 kg	50-60	45-50
Cucumber	April-May	2.0-2.5 kg	200-250	60-75
Bitter gourd	April-May	6.0-7.0 kg	150-200	60-75
Radish	November	7.0-8.0 kg	25-30	8-10
Ginger	April	1500-1800 kg	25-30	20-25
Turmeric	April	2000-2500 kg	35-45	25-30

V: variety H: hybrid

ecosystems. IPM does not require any additional budget; however it is economical and ecologically viable. Planning in advance for cropping pattern, selection of crops, selection of cultivars and time of sowing/ planting/ transplanting is of utmost importance.

- Emphasis should be given on use of resistant/ tolerant varieties suited to local situation.
- Avoid mono-cropping and monoculture practices.
- Use of trap crops fits well in IPM.
- Use of physical traps and repellants, pheromone traps and poison baits would be very imperative.
- Encourage predators, parasitoids, etc. for effective suppression of pests/ diseases.
- Emphasis should be given on use of bio-pesticides and botanical pesticides.
- Chemical pesticides, fungicides and weedicides should be used judiciously and need based only.

Hi-tech horticulture

High-tech horticulture is the modern technology which is less dependent on environment, capital intensive and has the capacity to improve the productivity and quality of horticultural crops. Adoption of this technology is necessary to ensure the food and nutritional security of ever increasing population and shrinking of land and water resources day by day, and to cope up with erratic and extreme type of weather events in impending climate change scenario. This includes micro-propagation, micro-irrigation, fertigation, protected cultivation (greenhouse/ poly-house, plastic mulching, low tunnel, etc.), mechanization, nutrition modeling, and use of remote sensing.

A Bangalore-based firm 'Zopar Export Ltd' with the support of Mizoram Government started production and export of flowers such as rose, anthurium, chrysanthemum, gerbera, lilium, limonium, orchid, etc., and strawberry from 2006. The firm has its own large production center at Vaipuanpho, Aizawl. Zopar is providing technological know-how in big-way to the state floriculture department's own flower farm at Champai as well as the progressive farmers of Aizawl and Champhai districts, and also marketing their produce to the National and International markets. More than 1,000 families are engaged in cultivation of the flowers in Mizoram, out of which 275 were Hi-tech producers. Entrepreneurship development through cultivation of flowers has not only brought about a change in the Horticulture scenarios of Mizoram, but also uplifted the living condition of the growers to a great extent. It is a successful model of Public-Private-Partnership (PPP) in which the roles of Mizoram Government, Zopar and growers are significantly synergestic and effective. The success story may also be replicate in vegetable crops (High-value and Low-volume).

On-farm trials (OFTs)/ front-line demonstrations (FLDs)

Poor communication and inadequate input delivery systems made it difficult to access the recent technologies and know-how. Therefore, there is need to conduct demonstrations/ OFTs/ FLDs as much as possible at farmers' field in the identified crops to convince the farmers about the efficacy and importance of various inputs in enhancing the productivity. Apart from this, field demonstrations, farmers' day, farmers' fair, yield competition, award and recognition, and media coverage will be very useful in making it interactive. The ICAR Research Complex, Kolasib has successfully demonstrated/ tested the various technologies at own Farm and farmers' field having significant impact on enhancing the productivity of vegetables such as adoption of Megha Turmeric-1 of turmeric (15-30 %); Avinash-2 and Arvind of tomato (20-35 %); KGMR-1, Blue Diamond and Ryozeki of cabbage (15-35 %); Nantes and Pusa Kesar of carrot (10-22 %); Harumi and Aishwaraya of broccoli (17-32 %); MZFB-27, MZFB-30 and MZFB-44 of French bean (20-30 %); MZCP-10 and MZCP-9 of cowpea (13-30 %); MZNC-1 of King chilli (30-62 %); Nadia and Thingpui of ginger (15-20 %); Arka Anamika and VRO-6 of okra (20-45 %); BSS-32 and Tejasiwini of chilli (15-22 %); MZAE-1 of African eggplant (15-25 %); Local-4 of chow-chow (20-25 %); leaf pruning of old vineyard in chow-chow (10-12 %), Naga chilli production under 50 % shade-net house (400-800 %); INM in tomato, cabbage, carrot, broccoli, French bean and chow-chow (15-20 %), application of borax in cauliflower and broccoli (15-28 %); and mulching in cauliflower, tomato, cabbage and broccoli (10-25 %).

Post-harvest management and processing

The state is lacking in trained personnel with sound knowledge of post-harvest management and processing of produces. There is also need to establish few units of post-harvest handling,

packaging, storage, processing industries, etc. especially for chow-chow, chilli, ginger and turmeric for value addition as well as to reduce the bulk transport.

Search of market for organic foods

Mizoram is one of the least users of inorganic fertilizers (80.9 kg NPK/ ha/ annum) and chemical pesticides, and the produce is almost organic in nature. Searching the markets for chow-chow, chilli, ginger, turmeric, etc. especially in Metro cities, and developed and economically sound countries would help in getting assured markets and good prices which will eventually help in strengthening the farming communities.

Collection, characterization, conservation and utilization of germplasm

The Lushai hill is blessed with rich bio-diversity of many vegetables. In the era of Plant Variety and Farmers' Right Act; collection, characterization and conservation of available gene pools would provide royalty to farming community for commercial utilization of their specific genetic resources. The utilization of available genetic resources will also assure the high productivity and well adaptability of developed varieties/ hybrids.

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