An Appraisal of Production Sustainability of Brinjal

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Abstract

Brinjal is one of the most commonly grown vegetables in India. The cultivation of brinjal generally takes place round the year. This paper evaluates the production system in terms of sustainability. The incremental growth in area and production of brinjal over the last five years indicates that a major change is realized in cultivation of brinjal by harvesting more returns per unit area over per unit cost. The observed sustainability yield index (SYI) of brinjal was 0.88 and it reveals that there is an expansion in area and production of brinjal in the district. Besides, the level of technological gap was also minimized from full gap - partial gap to partial gap - no gap. The use of fertilizers and pesticides were particular environmental concerns associated with the cultivation of brinjal. Therefore, more emphasis should be given in this direction, so that these two most important (INM & IPM) package of practices may not be ignored in future by majority of the farmers.

Introduction

Brinjal also known as eggplant is one of the most popular vegetables in the Indian sub continent due to its round the year availability. It serves as a cash crop and has high nutritional value for poor farmers with least resources. It is cultivated for the immature fruits which are roasted, fried, stuffed or cooked and pickled or processed. Brinjal occupies 6.80 lakh ha area with a production of 118.96 lakh metric tonnes in India (NHB, 2010-11). It also accounts for 28 per cent of the total vegetable production in India. Uttar Pradesh ranks second in vegetable production in India.

During 2010-11, U.P. occupied 2998 ha area under brinjal cultivation with a total production of 92099 tonnes and average productivity of 31t/ha (Naik and Singh, 2013). Due to its important place among the vegetables in eastern U.P., the crop has been selected for the study of production system sustainability. Eggplant is generally cultivated as a monocrop round the year. This practice greatly contributes to the escalating problem of insect pests such as shoot and fruit borer, green leafhopper and others.

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The concept of sustainability involves economic, environmental, technological as well as social aspects. A farming system, using recommended levels of technical inputs may be economically sustainable over a long term. Besides, if a farming system does not address the demands of society, it is not considered to be sustainable. The ultimate aim of sustainability is to develop farming systems that may be productive and protective to the environment and to enhance health and safety over the long term. This will depend on creative and innovative conservation and production practices to achieve this goal that provides to farmers, economically viable and environmentally sound strategies in developing their farming systems.

The environmental factors are composed of three dimensional factors: to reduce the quantity of pollutants in the environment, to increase the aesthetic quality of the environment and to make provision for ecological linkages and biodiversity of farms. The social factors relate to increasing habitat conservation, reduction in health cost by the farming system, and creating and strengthening communities through participation in farmers' groups.

Sustainable agriculture generally indicates an agricultural system adopted in a particular area in which crop and animal production do not decline over time and are reasonably stable over normal fluctuations of weather parameters (Edeoghon *et al.*, 2008). Sustainable agriculture also refers to the agricultural practices that guarantee human needs for food and fibre and at the same time protect natural resources and the quality of the environment (Edeoghon *et al.*, 2008). Some of these agricultural practices can be summarized as: multiple cropping, cover cropping, crop rotation, integrated pest management, alley cropping, organic manure application, improved plant varieties, green manure, minimum tillage system and mulching (Edeoghon *et al.*, 2008). Availability of reliable data on agricultural practices is of paramount importance for development planning and sustainable agriculture in brinjal growing areas of eastern U.P. The purpose of this study is to set baseline data about production systems, cultural practices, economic output and farmer's opinion about sustainability.

Methodology

The study was carried out in Bhadohi block, of Sant Ravidas Nagar district of Uttar Pradesh, having major area under vegetable cultivation. Major area under brinjal crop was identified from the block and five villages, Dalapur, Khetalpur, Dulamdaspur, Garulpur and Udhawamaphi were purposely selected. From each village 20 farmers were selected on the basis of stratified random sampling technique and data were collected personally with the help of a pre-tested structured schedule.

Thus a total of 100 respondents were selected for interview and to obtain the necessary information. After obtaining the base line data, the level of technological knowledge gap was ascertained. To elevate the level of knowledge among brinjal growers, KVK started with its extension programmes in the selected villages. A number of training programmes were organized on various aspects of scientific cultivation of brinjal on the basis of major thrusts realized by the level of technological gap. Two on-farm trials on shoot and fruit borer management in brinjal were organized with 10 progressive farmers. Front Line Demonstrations were also conducted in the fields of 10 progressive farmers. Field days and exposure visits were also organized for the farmers of adjoining villages to show the impact of improved technologies. For an appraisal of production sustainability of brinjal, a schedule was administered to the respondents. For measuring the social sustainability and environmental awareness, a three point rating scale was administered with the help of corresponding numerical values of 3, 2, 1 for agree, undecided and disagree, respectively. The above variables were categorized into three levels on the basis of (i) Mean - SD (ii) Mean ± SD (iii) Mean + SD as low, medium and high, respectively. However, to analyze the technological gap, a three point scale was used with full, partial and no gap, assigned score as 1, 2 and 3, respectively (Trivedi, 1963).

To assess technical sustainability, primary data were collected related to, over the time change in area and productivity of brinjal. An attempt was made to collect the primary data on trends in productivity of the crop in the study villages by having thorough discussion with the farmers. Sustainability yield index of crop enterprises was calculated by the following formula:

$$SYI = \frac{\tilde{y} - \sigma}{\tilde{y}\,max}$$

Where, SYI = Sustainability yield index

$\tilde{y}$ = estimated average yield of a practice over year

σ = estimated standard deviation

$\tilde{y}_{max}$ = observed maximum yield

A schedule was developed to measure the economic parameters, regarding cultivation of brinjal generally followed by farmers of the study area.

Results and Discussion

Technological Sustainability

The total area and production of brinjal in Sant Ravidas Nagar is presented in Table 1. During 2008-09 the area under brinjal cultivation was 3.92 ha and an 11.73 per cent increase was observed during 2009-10, 24.23 per cent increase in 2010-11, 30.10 per cent increase in 2011-12 and 34.69 per cent increase with an area of 5.28 ha during 2012-13. However, the corresponding yield of brinjal was 376.52 q/ha in 2008-09. It increased by 4.27 per cent during 2009-10 but with a gradual decline, production increased by 1.84 during 2010-11. Again it increased by 10.70 per cent and 13.47 per cent during 2011-12 and 2012-13, respectively, as compared to the base year i.e. 2008-09.

Table 1. Sustainability Yield Index of Brinjal

Years	Total Area (ha)	Per cent increase/decrease*	Yield of brinjal (q/ha)	Per cent increase/decrease*
2008-09	3.92	-	376.52	-
2009-10	4.38	11.73	392.60	4.27
2010-11	4.87	24.23	383.45	1.84
2011-12	5.10	30.10	416.82	10.70
2012-13	5.28	34.69	427.25	13.47
Mean	**4.71**		**399.33**	
SD	**0.56**		**21.81**	

* Percentage base year 2008-09

The incremental growth in area and production of brinjal over the last five years states that a major change is realized in cultivation of brinjal by harvesting more returns per unit area over per unit cost. It is certainly due to good agricultural practices disseminated by KVK, Sant Ravidas Nagar in the areas under brinjal cultivation. Farmers associated with cultivation of brinjal improved their economy with the help of improved package of practices. In order to derive the sustainability yield index the data obtained from previous years was analyzed with the help of the following formula

$$SYI = \frac{\tilde{y} - \sigma}{y\,max} = 0.88$$

The observed SYI of brinjal (0.88) is a highly significant value and it reveals that there is an expansion in area and production of brinjal in the district. Still there is a good scope to improve further.

It is evident from Table 2, that more than 65 per cent of the farmers fall under complete gap category regarding method of sowing, required seed bed and seed treatment. However, a significant per cent of the farmers exhibited partial gap in raising nursery. The gap was least, in case of most of the farmers, towards practices like seed rate and selection of varieties to raise the nursery.

Least gap was observed regarding field preparation (15%), transplanting distance (13%), fertilizer application (7%), weed management (18%) and plant protection (11%). However, for almost all the practices, a significant number of farmers reflected partial technological gap. These parameters were assessed as major thrust areas to be worked out during recent past years. The level of technological gap between previous years and recent years of study itself speaks about the impact of KVK activities in the selected villages. The farmers followed various improved practices to harvest more with less capital. In addition, Table 2 also reveals that level of full gap declined up to a significant level and level of no gap increased over the years.

Table 3 reveals about social sustainability. It indicates that culinary use (cheap and easy in preparation) of brinjal is most liked regarding cultivation and ranked 1st with a mean score of 97.3. The shoot and fruit borer observed as a major constraint ranked 2nd with a mean score of 96.6. The statement about cultivation of brinjal throughout year ranked third (mean score 93.0). Other statements pertaining to social sustainability viz., importance of brinjal due to heavy demand (4th rank), king of vegetables (5th rank), more profitable due to high yield potential (6th rank), cheapest source of nutrition (7th rank) and good cash crop which provides income for a long period (8th rank) along with mean scores 81.6, 77.0, 74.3, 72.3 and 69.7, respectively. Most of the statements were agreed by farmers and ranged (52-95 per cent) followed by disagree (3-43 per cent) and undecided (0-18 per cent). Kawasaki and Fujimoto (2009) also opined that the environmental and social impacts were the most important factors in improvement of production efficiency among four different vegetable farming systems.

Table 2. Level of Technological Gap in Cultivation of Brinjal

(N=100)

Sl. No.	Practices	Full gap				Per cent decrease	Partial gap				Per cent decrease /Increase	No gap				Per cent increase
		2008-09		2012-13			2008-09		2012-13			2008-09		2012-13		
(A)	**Nursery management**															
1	Selection of field	-	-	-	-	-	86	(86.00)	79	(79.00)	07 (-)	14	(14.00)	21	(21.00)	07
2	Field preparation	-	-	-	-	-	72	(72.00)	67	(67.00)	05 (-)	28	(28.00)	33	(33.00)	05
3	Varieties	23	(23.00)	-	-	23	66	(66.00)	23	(23.00)	43 (-)	11	(11.00)	77	(77.00)	66
4	Seed rate	-	-	-	-	-	45	(45.00)	17	(17.00)	32 (-)	55	(55.00)	83	(83.00)	28
5	Treatment of seed	100	(100.00)	68	(68.00)	32	-	-	15	(15.00)	15 (+)	-	-	17	(17.00)	17
6	Sowing time	-	-	-	-	-	77	(77.00)	61	(61.00)	16 (-)	23	(23.00)	39	(39.00)	16
7	Required seed bed	90	(90.00)	71	(71.00)	19	08	(08.00)	20	(20.00)	12 (+)	02	(02.00)	09	(09.00)	07
8	Method of sowing	87	(87.00)	77	(77.00)	10	13	(13.00)	15	(15.00)	2 (+)	-	-	08	(08.00)	08
9	FYM quantity	35	(35.00)	14	(14.00)	21	65	(65.00)	85	(85.00)	20 (+)	-	-	11	(11.00)	11
10	Fertilizers quantity	36	(36.00)	21	(21.00)	15	59	(59.00)	67	(67.00)	08 (+)	05	(05.00)	12	(12.00)	07
11	Irrigation	-	-	-	-	-	81	(81.00)	65	(65.00)	16 (-)	19	(19.00)	35	(35.00)	16
12	Weed management	40	(40.00)	34	(34.00)		51	(51.00)	48	(48.00)	03 (-)	09	(09.00)	18	(18.00)	09
(B)	**Main field**															
13	Field preparation	-	-	-	-	-	90	(90.00)	85	(85.00)	05 (-)	10	(10.00)	15	(15.00)	05
14	Age of seedlings	-	-	-	-	-	61	(61.00)	44	(44.00)	17 (-)	39	(39.00)	56	(56.00)	17
15	Transplanting distance	-	-	-	-	-	93	(93.00)	87	(87.00)	06 (-)	07	(07.00)	13	(13.00)	06
16	Gap filling	45	(45.00)	15	(15.00)	30	19	(19.00)	14	(14.00)	05 (+)	36	(36.00)	71	(71.00)	35
17	Manure application	40	(40.00)	30	(30.00)	10	70	(70.00)	60	(60.00)	10 (-)	-	-	-	-	-
18	Fertilizer application	-	-	-	-	-	100	(100.00)	93	(93.00)	07 (-)	-	-	07	(07.00)	07
19	Time of fertilizers application	29	(29.00)	05	(05.00)	24	65	(65.00)	68	(68.00)	03 (+)	06	(06.00)	27	(27.00)	21
20	Irrigation	-	-	-	-	-	85	(85.00)	77	(77.00)	08 (-)	15	(15.00)	23	(23.00)	08
21	Weed management	-	-	-	-	-	91	(91.00)	82	(82.00)	09 (-)	09	(09.00)	18	(18.00)	09
22	Plant protection	23	(23.00)	-	-	23	77	(77.00)	89	(89.00)	12 (+)	-	-	11	(11.00)	11
23	Harvesting	-	-	-	-	-	67	(67.00)	45	(45.00)	22 (-)	33	(33.00)	55	(55.00)	22

*Figures in parenthesis are percentages

Table 3. Opinion of Farmers on Social Sustainability regarding Brinjal Production

S. No.	Statements	Level of Measurements			Total score	Mean score	Rank
		A	UD	DA			
1.	Brinjal is an important vegetable in India due to huge demand in market	64 (192)	18 (36)	17 (17)	245	81.6	IV
2.	Brinjal is cultivable almost throughout the year	88 (264)	03 (06)	09 (09)	279	93.0	III
3.	It is the cheapest source of nutrition	55 (165)	07 (14)	38 (38)	217	72.3	VII
4.	It is used in preparation of chokha (an indigenous dish of eastern U.P. and Bihar) and various dishes	95 (285)	02 (04)	03 (03)	292	97.3	I
5.	It is called the king of vegetables	60 (180)	11 (22)	29 (29)	231	77.0	V
6.	It is more profitable due to high yield potential	59 (177)	07 (14)	32 (32)	223	74.3	VI
7.	Brinjal shoot and fruit borer is the major constraint in production and needs suitable control measure	95 (285)	0 (0)	05 (05)	290	96.6	II
8.	It is a good cash crop which provides income for a long period	52 (156)	05 (10)	43 (43)	209	69.7	VIII

(A = Agree, UD = Undecided and DA = Disagree)
* Figures in parenthesis are observed scores.

Distribution of respondents is exhibited in Table 4. It was observed that 68 per cent of the farmers were categorized under medium category. However, 11 per cent of the respondents who scored < 236 were categorized under low and 21 per cent respondents who scored > 259 categorized under high. The respondents belonging to medium and high category contributed 89 per cent magnitude together and it reflects high social sustainability.

Table 4. Distribution of Farmers on Social Sustainability regarding Brinjal Production

(N = 100)

Categories (Scores)	No. of Respondents	Magnitude (%)
Low (< 236)	11	11
Medium (236-258)	68	68
High (> 259)	21	21

Mean = 248.25, S.D. = 11.31

To measure the level of environmental sustainability, ten opinions were assessed and it was observed that the statement about decreased soil microbial flora and fauna due to higher use of fertilizers and chemicals had a mean score 99.3 and ranked first, (Table 5). It means that the farmers are quite conscious about safety of the environment. The statement, heavy infestation of brinjal fruit and shoot borer (BFSB) occurs in brinjal ranked 2nd with a mean score of 96.7. The other statements viz., indiscriminate use of pesticides leads to health hazards ranked 3rd (mean score 95.7), poor natural control of BFSB due to declining natural enemies ranked 4th (93.0 mean score), chemicals lead to adverse effect on environment ranked 5th (92.7 mean score). Almost all the statements related to BFSB opined that BFSB is a serious problem in cultivation of brinjal by which a huge amount of chemicals are applied in the field that creates serious environmental concerns. The statement that hybrid cultivation of brinjal requires heavy inputs ranked 6th (88.3 mean score). The statement that surveillance is an important tool in IPM had a mean score of 86.0 (7th rank), harvesting of fruits without considering waiting period creates toxicity to consumers obtained mean score of 83.3 (8th rank), use of botanicals are a safer and cheaper method of pest control ranked 9th (76.3 mean score) and continuous cropping of brinjal in the same field leads to soil sickness had 10th rank with a mean score of 60.7. Sharma *et al* (2003) also observed similar findings that application of even moderate dose of FYM, wheat straw and green manuring over a long period of time proved better than sole chemical fertilization to maintain productivity, soil health and sustainability in rice-wheat cropping system. Similar reports are also presented in a study that the introduction of long term participatory soil improvement strategies such as integrated soil fertility management (ISFM) relevant to Fadama lands is vital to improving the sustainability of crop production under Fadama (Ibrahim and Omotesho, 2009).

Table 5. Opinion of Farmers on Environmental Sustainability regarding Brinjal Cultivation

(N = 100)

S. No.	Statements	Level of Measurements			Total score	Mean score	Rank
		A	UD	DA			
1.	Hybrid cultivation of brinjal requires heavy inputs (fertilizers)	78 (234)	09 (18)	13 (13)	265	88.3	VI
2.	Decreased soil microbial flora and fauna due to higher use of fertilizers and chemicals	89 (267)	10 (20)	11 (11)	298	99.3	I
3.	Heavy infestation of BFSB occurs in brinjal	92 (276)	06 (12)	02 (02)	290	96.7	II
4.	Poor natural control of BFSB due to declining natural enemies	85 (255)	09 (18)	06 (06)	279	93.0	IV

S. No.	Statements	Level of Measurements			Total score	Mean score	Rank
		A	UD	DA			
5.	Indiscriminate use of pesticides leads to health hazards	90 (270)	07 (14)	03 (03)	287	95.7	III
6.	Harvesting of fruits without considering waiting period creates toxicity to consumers	71 (213)	08 (16)	21 (21)	250	83.3	VIII
7.	Continuous cropping of brinjal in same field leads to soil sickness	29 (87)	24 (48)	47 (47)	182	60.7	X
8.	Chemicals lead to adverse effect on environment	87 (261)	04 (08)	09 (09)	278	92.7	V
9.	Use of botanicals are the safer and cheaper method of pest control	58 (174)	13 (26)	29 (29)	229	76.3	IX
10.	Surveillance is an important tool in IPM	67 (201)	24 (48)	09 (09)	258	86.0	VII

(A = Agree, UD = Undecided and DA = Disagree)
*Figures in parenthesis are observed scores.

The respondents' level of environmental sustainability was categorized as depicted in Table 6. The respondents who scored less than 250 came under low category (31 per cent) and 64 per cent came under medium category (scoring 251-272). However, only 5 per cent of the respondents were categorized under high category (scored more than 273) towards environmental sustainability.

Table 6. Distribution of Farmers on Environmental Sustainability regarding Brinjal Production

(N = 100)

Categories (Scores)	No. of respondents	Magnitude (%)
Low (< 250)	31	31
Medium (251-272)	64	64
High (> 273)	5	5

Mean = 261.6, S.D. = 11.6

It is clear from Table 7 that total input cost of brinjal cultivation incurred by farmers was Rs. 42860.25 per ha while gross income was obtained as Rs 322800.20 per ha. However, net income of Rs. 252840.70 per ha and Benefit cost ratio 4.92:1 were realized from brinjal cultivation in Sant Ravidas Nagar during 2012-13.

Arsanti and David (2008) also stated that the farmers are required to go through a serious learning process in order to know how to implement good agricultural practices. By combining their farming experience and knowledge of the area and scientific knowledge on topography, soil microbiology, plant nutrition, pest and

disease management, viable methodologies for converting farms, such as organic vegetable farming system and multiple cropping pattern, could emerge.

Table 7. Assessment of Economic Parameters of Cultivation of Brinjal

S. No.	Particulars	Amount
1.	Labour cost (Rs/ha)	22800.00
2.	Total input cost (Rs/ha)	42860.25
3.	Gross income (Rs/ha)	322800.20
4.	Net income (Rs/ha)	252840.70
5.	Cost of production (Rs/q)	130.04
6.	Benefit cost ratio	4.92:1

A similar study conducted by Tiwari *et al.* (2008) showed that adoption of vegetable farming improved the socio-economic condition of the upland farmers, particularly the poor, women and disadvantaged groups, in terms of their food security, farm income, resource accessibility, employment opportunity and social status. These indicators revealed that vegetable-based cropping patterns are economically profitable and socially acceptable and thus contribute somewhat to the sustainability of upland farming. However, such achievement has been made possible through intensive cultivation practices such as increased use of agrochemicals and hybrid seed, that have led to declining soil fertility and increasing dependency of farmers on external inputs in commercial vegetable production and, therefore, threaten the sustainability of mountain farming in the long run.

Conclusion

In respect of technical sustainability, under different agricultural practices, most of the respondents did not adopt the plant protection measures quite well in cultivation of brinjal. Farmers used to spray synthetic chemicals against brinjal shoot and fruit borer in a frequent manner over a long cropping period. In this way, there has been huge insecticidal pressure under brinjal cropping system which leads to detrimental effect on the environment and human health. In addition, it also added huge monetary cost. Despite having high cost under cultivation, the present study indicated better technical sustainability, however, it needs to be enhanced further.

Moreover the constraints observed under brinjal cultivation should be analyzed and efforts made to minimize the same so that a large number of farmers may be attracted towards the cultivation of brinjal in respect of social sustainability. Besides being the cheapest source of nutrition, brinjal crop captures the Indian market almost round the year validating that it is a good cash crop.

To optimize environmental sustainability, the use of balanced fertilizer and integrated plant nutrient management are required for supplying essential plant nutrients in optimum quantities through appropriate methods and time for brinjal crop so as to get maximum economic yield without any deleterious effect on the physico-chemical and biological properties of the soil. Use of green manure, FYM and bio-fertilizers are better options to sustain the potential productivity of brinjal crop, which not only supplies the essential micro and macro nutrients but also protects the environment. Besides, application of synthetic chemicals leads to serious health hazards to humans and the surroundings. Therefore, more emphasis should be given in this direction, so that these two most important (INM & IPM) package of practices may not be ignored in future by a majority of the farmers. Though, there is a good impact of KVK activities to alleviate the problems in cultivation of brinjal, however, in order to make it more viable it still needs further expansion and refinement as and when needed by farmers. The proper technique and method should also be demonstrated as and when needed by farmers to make cultivation of brinjal technically more viable. Additionally, to ensure environmentally and socially sustainable production, government policy and programmes should promote locally available resources for production of brinjal along with market support mechanisms which can be competitive in domestic and national markets.

References

Arsanti, Idha Widi and David, Wahyudi (2008). Sustainability of Vegetable Farming System in Upland Areas of Indonesia. In: Proceeding of Indonesian Students' Scientific meeting, Delft, The Netherlands, May 2008. P 12-17.

Edeoghon, C. O., Ajayi, M. T. and Ugboya, T. O. (2008). Awareness and Use of Sustainable Agricultural Practices by Arable Crop Farmers in Ikpoba Okha Local Government Area of Edo State. J. Sustain. Dev. Agric. Environ. 3(2): 55-63.

Ibrahim, H. and Omotesho, O.A. (2009). An assessment of the sustainability of vegetable production under Fadama in the Northern Guinea savannah zone of Nigeria. Electronic Journal of Environmental, Agricultural and Food Chemistry, 8(11): 1156-1163.

Kawasaki, Jintana and Fujimoto, Akimi (2009). Sustainability assessment of organic vegetable cultivation in Chiang Mai, Thailand. J. ISSAAS 15 (2): 42-55.

Naik, P.S. and Singh, B. (2013). Status of vegetables in Uttar Pradesh. In proceedings: National Symposium on Abiotic and Biotic stress management in vegetable crops April 12-14, 2013 Indian Institute of Vegetable Research, Varanasi.

Sharma, R.P., Singh, S.N., Mohan, K. and Pathak, S.K. (2003). Effect of integrated nutrient supply on crop productivity and soil fertility in rice wheat cropping system. J. Farming Systems Research and Development, 9(1): 19-22.

Tiwari, Krishna R., Nyborg, Ingrid L.P., Sitaula, Bishal K. and Paude, Giridhari S. (2008). Analysis of the sustainability of upland farming systems in the Middle Mountains region of Nepal. International Journal of Agricultural Sustainability, 6(4): 289–306.

Trivedi,G. (1963). Measurement and analysis of socio-economic status of rural families. Ph.D. Thesis, Indian Agricultural Research Institute, New Delhi.