Agricultural Economics Research Review
Vol. 19 July-December 2006 pp 251-268

Economic Impact of Commercial Hybrid Seed Production in Vegetables on Farm Income, Employment and Farm Welfare – A Case of Tomato and Okra in Karnataka

M. Sudha, T.M. Gajanana and D. Sreenivasa Murthy

Abstract

Commercial Seed Production (CSP) in vegetables like tomato and okra is an important economic activity for farmers in the dry regions like Haveri and Gadag in Karnataka providing assured returns and additional employment. Its economic impact assessed at individual and aggregate levels based on a sample of 70 cultivators has indicated that the activity provides stability, equity in income distribution across the group and helps enhance family welfare. Undertaken mainly during the *khraif* season on a plot of around 0.43 ha, the farmers incur an expenditure of around Rs 49,780 / ha for tomato and Rs 38,555/ha for okra. With a seed yield of 0.493 and 5.66 quintals of tomato and okra, respectively, the farmers could realize a net return of Rs 88,338/ha from tomato and Rs 39,440/ha from okra. Being highly labour-intensive involving special operations such as emasculation and hybridization, the commercial seed production generates employment opportunities of around 415 women-days in both tomato and okra CSP. With low coefficient of variation in the range of 8 per cent price in okra to around 28 per cent for yield in tomato, the CSP could provide income stability for the dryland farmers. Measured in terms of Gini's coefficient of income equality, the CSP of tomato and okra with a value of 0.22 and 0.24 has proved to improve income distribution across the group. By adopting a combination of two plots of tomato, one during *kharif* and one during *rabi*, with one plot of okra in *kharif*, CSP could fetch the highest net return of Rs 33,859/ha. The presence of surrogate water market and dwindling groundwater in the region highlight the urgent need for a policy and action points for safeguarding the social and environment issues in the highly beneficial CSP of tomato and okra.

Section of Economics and Statistics, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore 560 089. e-mail **:** sudhamys@yahoo.com
The authors thank the referee for providing helpful suggestions.

Introduction

Despite being the world's second largest producer of vegetables, India lags far behind in their productivity in comparison to that in developed countries (Sharma and Pandey, 2003; Verma *et al.*, 2002). Increased availability and adoption of improved varieties or hybrids have been recognized as a plausible solution for enhancing the productivity levels of vegetables. Commensurate with this view, there has been an increasing trend in the adoption of hybrid seed technology in vegetables like tomato (40 %), cabbage (68.6%), brinjal (82%) and Okra (10 %) during the past two decades. This technology, though capital- and labour-intensive, has increased the profitability of farmers through enhanced productivity. But, the increased adoption also warrants increased availability of hybrid seeds to the farmers. Seed production in vegetables, especially of hybrids, though a specialized skilled activity, was transformed into a commercial economic activity by the private seed companies way back in the late-1970s and was largely undertaken on the farmers' fields. This could be considered a spill over effect of technological advancement in view of the agro-climatic suitability of a specific area, besides availability of other factor endowments. The commercial (on-farm) seed production in vegetables undertaken in India not only meets much of the requirement of domestic demand but also fetches foreign exchange for the country, and thus adds substantially to the economic development of the farm families.

Commercial seed production in vegetables is gaining popularity with the farmers and private seed companies, as it is undertaken mainly in dry areas for want of suitable agro-climatic conditions for increased seed set. This forms an important economic activity for all those farm families who otherwise have dwindling income from dryland farming due to recurrent drought conditions. Besides providing additional income and employment generation, the commercial hybrid seed production or seed multiplication has several other impacts that need careful evaluation. There has not been any attempt so far at assessing the economic impact of the commercial (on-farm) production of vegetable seeds in a holistic manner. Hence, this study was undertaken with the specific objectives of (i) assessing the economic impact of Commercial Seed Production (CSP) in vegetables like tomato and okra on farm income and employment, and (ii) evaluating the socio-economic implications on stability, equity, farm welfare and environment.

Materials and Methods

Study Area and Data Collection

'Ranebennur' in Karnataka state is a globally known 'Seed Production / Multiplication Centre', where a number of seed companies in the private

Table 1. Details of selected farmers of CSP

Sl No.	Particulars	Sample farmers
1	Tomato	25 (35.7)
2	Okra	16 (22.9)
3	Tomato and okra	29 (41.4)
	Total	70 (100.0)

Percentage of farmers for different companies : Mahyco: 27 (Tomato), 46 (Okra); Namdhari: 24 (Tomato) , 24.3 (Okra); Numhems : 33 (Tomato) 24 (Okra); IAH : 15 (Tomato) 4 (Okra)
Figures within the parentheses are percentages to total

and public sectors have been undertaking CSP / multiplication in vegetables since long. Haveri and Gadag districts in the state of Karnataka being the representative regions for tomato and okra seed production, were purposively selected as the study area[1] . Based on the popularity and accessibility to the commercial seed companies, four companies, viz., Mahyco, Namdhari, Nunhems and Indo-American Hybrid Seeds (IAHS) were approached and with their cooperation, a total of 70 farmers were contacted for collecting data on costs, returns and profits from commercial (on-farm) seed production in tomato and okra for the agricultural year 2003-04. The details of classification of the selected farmers are given in Table 1.

Analytical Framework

The studies so far have evaluated the impact of technology on income and employment generation from the angle of adoption of new varieties and not from the view point of stability, equity and sustainability (Sudha and Subrahmanyam, 1993 and Subrahmanyam and Sudha, 1997). Hence, efforts have been made in this study to assess the economic impact at the level of both individual farmer and group /aggregate level.

Individual Farmer level

(i) Income from the specified activity vs income from the other farm activities

Haveri and Gadag districts in Karnataka state fall under the Transitional Dry zones with an average rainfall of less than 700 mm / annum. These dry hot belts are ideally suited for seed multiplication in a number of crops, especially vegetables. The cropping pattern in these areas is one of typically rainfed farming, based mainly on the *kharif* crops, including cotton, bajra,

[1] The CSP has changed substantially and regional specializations for specific crops have emerged over the years.

maize, jowar, groundnut and sunflower, fetching the farmers an average net income of Rs 7443 / ha, when the rainfall is normal. During the years of sub-optimal rainfall (like the ones experienced during the *kharif* seasons in 2001 to 2003,) much of the area is left fallow. Under such circumstances, allocation of a small proportion of farm area (around 25 %) towards commercial seed production of vegetables provides an income-security to the farmer, as the activity is regular and is undertaken year after year in the region. Therefore, to assess income effect of CSP, the income from CSP was compared with that from the other crops regularly grown in the region.

(ii) Employment generated from the adoption of specific activity

Unlike regular crop production, the CSP includes special operations such as emasculation, hybridization, harvesting and cleaning of seed, which require additional labour. Since most of these operations are performed mainly by the farm women, CSP not only generates additional employment opportunities but also provides employment security to the women.

(iii) Farmers' perception of welfare accrued to the farm family

The impact on family welfare has been assessed through the farmers' perception on the income enhancement, increased socio-economic status and family welfare

Group of Selected Farmers: The impact of technology adoption has been assessed on enhancing the economic stability and improving the equity in income distribution at the group level and the impact on the environment.

Methods of Analysis

Besides simple tabular analysis and percentages involving the cost of cultivation, profitability and benefit cost ratios, coefficient of variation (CV)[2] and the Gini's coefficient of income distribution and Lorenz curves were used for analyzing the data.

---

[2]CV = (Standard Deviation / Mean) × 100

Mean

$\bar{X} = (\sum X_i)/n$

where,

n = Number of observations, X_i = The ith observation

Standard Deviation

$$\sigma X = \sqrt{\sum (X_i - \bar{X})^2 / n},$$

where,

n = Number of observations, X_i = The ith observation.

$\bar{X}$ = Mean of the observations (weighted average was taken)

Gini's Coefficient (G)

The Gini's coefficient of inequality measures the area below the diagonal of the perfect inequality to the Lorenz curve as a proportion of the total triangular area, represented by a line of perfect equality. The Gini's index of inequality ranges between 0 and 1. Gini's Coefficient of '0' represents perfect equality, while '1' represents greater inequality. It is represented by Eq. (1):

$$G = 1 - \sum_{i=0}^{N} (\sigma Y_{t-1} + \sigma Y_t)(\sigma X_{t-1} - \sigma X_t) \quad \ldots(1)$$

where, σX and σY are cumulative percentages of X's (farmers) and Y's (income) (in fractions) and N is the number of elements (observations).

Index of Dissimilarity

The index of dissimilarity (ID) is given by Eq. (2):

$$ID = 0.5 \sum_{i-1}^{N} |X_i - Y_i| \quad \ldots(2)$$

Lorenz Curve

It is a graphic representation of the degree of income inequality. Plotting cumulative income and cumulative population on a graph generates the Lorenz curve. If the income were to be equally distributed, the Lorenz curve would be a 45 degree line, while an unequal distribution of income would generate a curve below this line. The greater equality is associated with the convergence of Lorenz curve with the diagonal.

Results and Discussion

Some Salient features of Commercial (on-farm) Seed Production

Commercial (on-farm) seed production in vegetables could be traced back to the late-1970s, when contract farming was brought into India[3]. Normally, the public or private seed companies enter into a written/oral contract with farmers individually for the production and supply of seed at a prefixed rate[4]. The supply of inputs besides the seeds (breeders or foundation

[3] Indo-American Hybrid Seeds was the first private company to initiate on-farm production of tomato hybrid seeds in Karnataka during the late-1970s. It was the seed multiplication in maize by Hindustan Lever Ltd., which introduced contract farming into India.

[4] National Seeds Corporation (NSC) used to undertake the seed multiplication for most of the cereals and some vegetables on contract basis.

seeds) is optional in the contract[5] . Technical guidance for crop cultivation, special operations such as emasculation, pollination and hybridization, harvesting and processing are provided to the farmers through regular field visits by the trained supervisors.

Generally, the seed companies allot a specific area for seed production, such as one acre in case of tomato and or 1.25 acres in case of okra (which is called a 'plot') and provide the requisite number of seedlings (normally 25 day-old) of both the parents for maintaining the plant population for hybridization and seed production.

The seed or seedlings are charged along with a service charge for supervision, seed testing, etc. One plot per person per crop is a norm, keeping in view the additional labour and capital needs as the entire process of cultivation, processing and seed testing takes around eight months for the grower to receive the total emoluments.

Economic Impact of Commercial Hybrid Seed Production in Tomato and Okra

The Impact of CSP on Income

The costs, returns and profits from hybrid seed production in tomato and okra have been presented in Table 2.

Tomato: On an average the cost of cultivation of tomato hybrid seed production worked out to be Rs 49,775/ha. The material inputs such as seed/seedlings, FYM, fertilizers and pesticides, special operations such as staking, etc. worked out to be Rs 23,576 accounting, for 47.37 per cent of the total cost of seed production. Expenditure on labour(hired) was found as Rs 17793, accounting for 35.75 per cent of the total costs. The imputed value of family labour worked out to be 6 per cent of the total operational costs.

Though, *kharif* was the most preferred season for seed multiplication in most of the crops, in the case of tomato, it was possible to take up two crops (both *kharif* and *rabi*) in a year. Growers realized a seed yield of around 0.50 quintal in tomato and a gross income of Rs 1,38,118 /ha with an average price of Rs 2,80,159/q of seed, thereby fetching the growers a net realization of Rs 88,343 / ha per season. The BCR worked out to be 2.72.

Okra: The hybrid seed production in okra is normally undertaken on an average area of around 0.44 ha. The cost of production for okra seed worked out to be Rs 38,548/ha with material inputs such as seed/seedlings, manures, fertilizers and pesticides accounting for about 42.31 per cent of this total. The hiring of labour involved Rs 14,356, accounting for 37.24 per cent of

[5] In the case of contract production of tomato by Pepsi in Punjab also, the seed cost is collected from the farmers.

Table 2. Costs, returns and profits from commercial hybrid seed production in tomato and okra

(Per ha)

Particulars	Tomato		Okra	
.	Quantity	Value (Rs)	Quantity	Value (Rs)
A. Material input cost (paid out)				
Seed / Seedlings		865		1111
FYM (tonnes)	4.41	2003	5.97	1951
Stakes (No.)	7298.9	6486	-	-
Thread / wire (kg)	17.09	635	7.66	242
Fertilizers, kg				
N	101.39		107.53	
P	138.4	4961	139.7	7804
K	136.1		137.3	
Pesticides (Qty- No. of sprays)	17	8195	15.94	4739
Electricity charges (Rs/crop/season)		431		462
Sub Total		23576		16309
		(47.37)		(42.31)
B. Labour (mandays)				
Hired labour	382.18	17209	296.77	13876
Bullock power		584		480
Sub-total		17793		14356
		(35.75)		(37.24)
C. Interest on working capital (10% pa)		4137		3066
D. Total variable cost (A+B+C)		45506		33731
		(91.42)		(87.50)
E. Fixed costs*		1209		1074
		(2.43)		(2.78)
Sub-total (D+E)		46715		34805
		(93.85)		(90.29)
F. Imputed value of owned labour	79.36	3060	101.38	3743
		(6.15)		(9.71)
G. Total cost of cultivation (E+ F)		49775		38548
		(100.00)		(100.00)
H. Yield (q)	0.493		5.66	
I. Price (Rs / q)		280159		13780
J. Gross return (Rs)		138118		77995
K. Net return (Rs) (J-G)		88343		39447
L. Family labour income (J- (D+E))		91403		43190
M. Own farm business income (J- D)		92612		44264
Benefit-cost ratio		2.77		2.02

*Includes rental value of land,

Note: Figures within parentheses indicate percentages to total cost of cultivation. Area and sample size: **Tomato:** Byadagi, Ranebennur and Shirahatti, 54 growers; **Okra:** Byadagi, Ranebennur, Shirahatti and Mundragi, 41 growers

the total cultivation expenses. The growers realized the seed yield up to 5.66q and price of Rs 13780/q, resulting in a gross return of Rs 77,995 and a net profit of Rs 39,447 with a BCR of 2.02.

Income from Other Crops

The income effect of CSP in tomato and okra in the Haveri region has been depicted in Table 3(a & b). Different crop combinations and crop

Table 3. Income effect of CSP in tomato and okra

Crop combinations	Average cropped area per farm (ha)	Average expenditure (Rs/ha)	Average net returns (Rs/ha)	B:C ratio
	(a) Tomato			
Maize (55%); Cotton (45%)	1.46	10,000	5,730	1.57
Maize (47%); Cotton (39.3%); Hyb. tomato (SP) 13.7%	1.70	20,472	19,409	1.95
Additional area / returns	0.24		13,679	
Cotton (50%); Jowar (50%)	0.32	13,250	9,150	1.69
Cotton (40%); Jowar (40%); Hyb. tomato (SP) (20%)	0.40	30,960	25,960	2.19
Additional area / returns	0.08		16,810	
	(b) Okra			
Sunflower (60 %), Groundnut (20 %), Hyb. maize (20 %)	0.33	9,700	2,337	1.24
Sunflower (50 %), Ground nut (16.66 %), Hyb. maize, (16.66 %) Okra SP (16.66 %)	0.40	14,797	14,077	1.95
Additional area / returns	0.07		11740	
Bajra (50%), Sunflower (25 %) Groundnut (25 %)	0.35	8,625	2,562	1.29
Bajra (44.5%), Sunflower (22.2 %), Groundnut (22.2 %), Okra SP (11.1 %)	0.40	12,954	8,240	1.63
Additional area / returns	0.05		5677	

sequences normally followed in the region along with the costs and returns have been compared with those from the CSP. In the tomato CSP region, cotton was the most important *kharif* crop. Besides, maize (hybrid), jowar, bajra among the cereals and cabbage and chilli among the vegetables were widely grown during the season. The cotton and maize crop sequence fetched a net return of Rs 5730/ha, while the allocation of around 13.7 per cent of the cropped area to CSP of tomato, could fetch to the farmers an additional net gain of Rs13,679/ha, nearly 2.3-times more than that without CSP. Similarly, the net realization from allocating around 20 per cent of the area to CSP of tomato could add Rs 16,810/ha to that from the crop combination of cotton and jowar grown during the *kharif* season. The BCR also has increased from 1.69 to 2.19 with CSP of tomato.

Similar was the case for okra seed production. In the Gadag taluk, which was the most popular location for CSP of okra, the general cropping pattern included sunflower, groundnut and hybrid maize. The income effect due to CSP in okra has been shown in Table 3 (b). By allotting around 21 per cent of the farm area to CSP in okra, the growers could more than double their net gain per hectare. The cropping intensity in all the cases with CSP in okra increased.

Employment Generation

The second significant impact of CSP in vegetables at the individual farm level was the employment generation potential. The CSP of hybrids is highly labour-intensive as it involves the manual emasculation and hybridization, besides the other regular crop production activities. On an average, eight women were employed for over a month during the crossing period in tomato and okra, besides other operations such as staking, tying thread, etc. The crossing operation was a highly specialized job and was found highly successful when performed by woman/young girls during the early morning hours. The wage rates were also higher at Rs 40/day for this operation in comparison to Rs 30/day for the regular operations like weeding, sowing, etc. Also, since it is a typically rainfed area, the other commercial crops were ragi, maize, cotton requiring less labour (Table 4).

Tomato: Employment for a total of 104 man-days and 417 woman-days was generated from CSP of hybrid tomato. The emasculation and hybridization operations alone generated an additional employment of 275 woman-days per ha. The harvesting and cleaning of hybrid seeds also required more time and attention and hence was done mainly by women. Nearly around 74 additional woman-days of employment was generated from this operation alone. The wage bill for emasculation and hybridization

Table 4. Employment generation from hybrid seed production in tomato and okra

Sl No.	Operations	Tomato					Okra				
		Own		Hired		Cost	Own		Hired		Cost
		M	F	M	F	(Rs)	M	F	M	F	(Rs)
1	All operations	45.39	10.30	55.75	67.54	5972.05	57.88	21.44	18.13	69.06	4955.03
2	Emasculation and hybridization	5.48	21.30	11.34	275.48	10976.05	6.67	11.56	1.44	257.22	9691.10
3	Harvesting, cleaning and packing	3.56	5.78	37.12	73.90	3321.64	7.61	10.84	2.39	85.94	2973.14
4	Total	54.43	37.38	104.21	416.92	20269.74	72.16	43.84	21.96	412.22	17619.27

M=Man-days , F= woman-days

accounted for more than 54 per cent of the total cost of labour for all operations. A comparison of labour-use for CSP and commercial crop production in tomato has indicated (Sudha and Subrahmanyam, 1993) that the CSP of tomato required more than double labour than that in commercial vegetable cultivation.

Okra: The employment generation in CSP of okra was of around 412 woman-days. The emasculation and hybridization operation alone accounted for over 257 woman-days, which was nearly 47 per cent of the total labour employed in the okra CSP. Similar to tomato CSP, the emasculation and hybridization operations in okra CSP also were performed by women, thereby generating additional women employment. The total wage bill in the case of okra CSP was around Rs17619, which was around 46 per cent of the total cultivation expenditure.

Family welfare

The farmers who were involved in CSP of tomato and okra opined that the technology had provided them income as well as employment security. Most of the growers were involved in the programme for more than ten years with one company or the other. The impact of the CSP on the welfare of the growers included:

(i) Reinvestment into agriculture, such as purchase of additional land,

(ii) Procurement / acquisition or construction of dwelling house,

(iii) Higher education for children,

(iv) Better health facilities for the family and better standard of living for their children.

Based on the responses of the growers, irrespective of the crop, it could be inferred from Table 5 that income effect was the most significant reason for the growers opting for CSP. Family welfare ranked the second important reason with reinvestment into agriculture, followed by the marriage of their wards as the most important attributes of the family welfare. Repayment of loans was the third in the order of preference of majority of the growers.

Impact at Aggregate Level

Stability in Income

The commercial (on-farm) seed production in tomato and okra were considered to be more stable income-generating activities in comparison to other farm production activities. It was because of high dependency on the

Table 5. Socio-economic impact

Reasons	Per cent to total
A. Impact on social status	
• Acquired membership in a society	20
• Won awards (best producer)	1
B. Impact on household income	
Total income increased up to 25 %	93
• Bought new household items	7
• Able to buy better food /clothing / jewellery	7
• Able to perform social functions	13
C. Impact on family welfare	
• Bought additional land for the household	52
• Performed child's marriage	23
• Sent son /daughter for higher education	11
• Health improvement	11
D. Impact on creditworthiness	
• Able to repay loans	32

Note: n=70

rainfed farming in the study area, with the main focus on *kharif*-based cropping pattern[6] . Table 6 presents the coefficient of variation (CV) in yield, price and net income of different crops popularly grown along with those from CSP of tomato and okra. The CV for the net income from CSP tomato was the lowest at 40.97 as compared to that of okra, cotton, onion, hybrid maize or jowar, reflecting the wide popularity of CSP of tomato in the region

The variability in yield and price realization was higher in the popularly grown *kharif* crops like maize and jowar and hence there was higher variability in income as well. Although the net gain from dryland crops like hybrid maize and jowar was lower and the price and income variability were much higher compared to those from the CSP of tomato and okra. The farmers cultivated these crops to meet their domestic food and fodder requirements. In the case of other crops of the region, viz. cotton and onion, it could be seen that the yield variability was lower than that of CSP crops, but the variability in price or net returns was much higher than that of CSP crops. Hence, adoption of CSP of tomato or okra at least in one season was highly preferred as it provided the farmers stability and security of income.

[6] Discussions with farmers in the study area indicated that due to the failure of monsoon in two consecutive years, the production of regular *kharif* crops of the region, viz. Cotton, maize (hybrid) and jowar was reduced substantially and the farmers were totally dependent on the vegetable hybrid seed production.

Table 6. Variability and income stability of CSP of tomato and okra

Name of the crop	Coefficient of variation in					
	Yield (q/ha)		Price (Rs/q)		Net return (Rs/ha)	
	Mean	CV,%	Mean	CV,%	Mean	CV,%
Tomato CSP	0.49	28.47	2801	37.99	88338	40.97
Okra CSP	5.66	34.99	13780	8.39	39065	72.17
Cotton	12.12	27.13	3491	52.01	10218	53.36
Hybrid maize	9.18	40.54	790	49.75	-522	-435.93
Jowar	16.06	49.16	773	98.01	1484	171.82
Onion	59.20	29.02	533	8.50	5385	200.88

Between CSP of tomato and okra, the income variability was lower for tomato, which justified its preference by growers. Though the variability in price realization was much lower in the case of CSP of okra, the higher variation in yield realized was causing greater variability in the net income from CSP of okra. The fact that tomato can be grown in both *kharif* and *rabi* seasons and the net gain was higher justified the popularity of tomato CSP in this region.

Equity in Income Distribution

Hybrid seed productions in tomato and okra were helping the farmers by reducing the inequality in income distribution across a group of growers. The estimation of Lorenz curve and Gini's coefficient of income equality indicated that the income distribution from seed production is more equitable

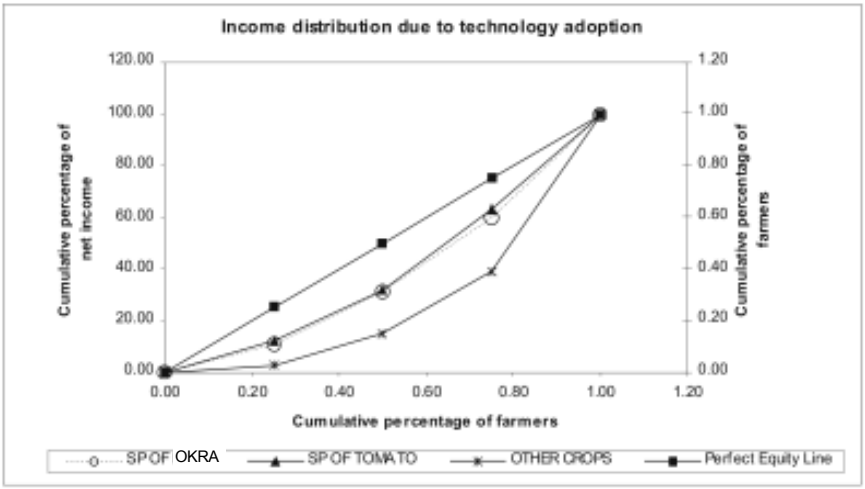

Fig. 1. Income distribution pattern of tomato seed production, okra seed production and commercial production of other crops

compared to that from other commercial crops. Nearly uniform price and uniform area allocation could be the important reasons for higher equitable income distribution. Frequent failures of monsoons, leading to persistent drought conditions, could be the reasons for low and highly fluctuating yields of most of the crops grown in the region, causing wide variation in income as well. The Gini's coefficient of equity worked out to be 0.22 in tomato and 0.24 in okra compared to 0.45 for other crops, indicating the more equitable distribution of income from CSP.

Income Maximization Strategy

The CSP of tomato and okra provided the income security to the farmers in the Haveri-Gadag region. It was equally important for the vegetable seed companies from the point of ideal weather for seed production. Since a number of private seed companies have been operating their CSP of tomato and okra in this region, there was a competition between the companies to attract and retain farmers. While the companies aimed at an assured clientele, farmers tried to maximize the net gain from the CSP. As a result, new models of CSP with a combination of crops have emerged to satisfy the needs of both the farmers and the companies. One of the most popular ones was the production of tomato CSP for two seasons along with one season of okra CSP. The returns were maximum in this model at Rs 90,769 /ha as compared to all other combinations. Hence, this was the most preferred model with a number of growers opting for it (Table 7).

Negative Impact of CSP in Tomato and Okra

Although the CSP in vegetables like tomato and okra have largely helped the farmers in realizing higher remuneration and increased employment opportunities, the continued CSP in one region was found to have some negative impacts also.

Over-exploitation of Groundwater

The most serious negative impact of CSP was the increasing exploitation of groundwater. Since CSP was the most significant contributor to the average annual income of the households in the otherwise dry region, the farmers tried to have at least one 'plot' of CSP in tomato or okra. Therefore, there was a rush for digging bore-wells. On an average, each of the farmers had sunk 6 to 7 bore-wells during the past five years, involving an average expenditure of over Rs 75,000 per well, with hardly one or two in the working condition. This was considered inevitable, both from the point of keeping the contract with the seed company alive and to have some assured income

Table 7. Income maximization modules with CSP in tomato and okra

Crop combinations	Average cropped area per farm (ha)	Percentage area allotted for different crops	Average expenditure (Rs/ha)	Average net returns (Rs/ha)	B:C ratio
Maize; Cotton; Hyb. tomato (SP)	1.70	47 % (Maize), 39.3 % (Cotton), 13.7 % (Tomato SP)	20,472	19,409	1.95
Sunflower; Groundnut; Hyb. maize; Okra (SP)	0.40	50 % (Sunflower) 16.66 % (Groundnut) 16.66 % (Hyb. maize) 16.66 % (okra SP)	14,797	14,077	1.95
Bajra; Cotton; Hybrid maize Finger millet / Paddy/ Savi /Onion and Garlic Hyb. tomato (SP) (K&R); Okra (SP) (K)	4.95	30 % (Bajra) 14% (Cotton) 10% (Hybrid maize) 18% (Onion, garlic) 28% (Tomato & okra SP)	19,299	33,859	1.75

against the erratic monsoon. As a result, the number of bore-wells had largely increased, though the net area irrigated did not increase in the same proportion as the standard distance between bore wells might not have been maintained while digging new wells.

It was verified by the taluk-wise data on increase in the number of bore-wells over the years (Table 8). Between 1985 and 2004, the number of bore-wells in the Gadag taluk had increased from 10 to 122, registering a 12-times increase, while it increased from 521 to 3618 in Haveri, a 36-times increase. It was of significance to note that though the net irrigated area registered a commensurate increase, it was negative in Haveri from 1994-95 on wards. Despite the increased number of bore-wells in the region, the net irrigated area has been falling, indicating the increase in failure of bores, strengthening the argument of over-exploitation of the groundwater due to CSP, especially in Haveri.

Existence of Exploitative Land and Water Markets

A surrogate water market was in operation in this region, with growers purchasing water at high prices. Leasing-in of land including water charges for agreement of sharecropping was a common feature in this region. On

Table 8. Changing pattern of bore-wells and net irrigated area in Gadag and Haveri taluks, Karnataka

Year	No. of bore-wells	Change over previous period, %	NIA (ha)	Change over previous period, %
		Gadag taluk		
1985-86	10	0.0	17	0.0
1990-91	70	600.0	160	841.2
1994-95	82	17.1	955	496.9
2000-01	82	0.0	1100	15.2
2003-04	122	48.8	2068	88.0
		Haveri Taluk		
1985-86	521	0.0	999	0.0
1990-91	964	85.0	2931	193.4
1994-95	1453	50.7	7655	161.2
2000-01	1944	33.8	6328	-17.3
2003-04	3618	86.1	5802	-8.3

NIA = Net irrigated area (ha)

Source: *Annual Season and Crop Statistics Report*, Directorate of Economics and Statistics, Karnataka.

an average, Rs 2750 were the leasing-in charges per acre/annum. In return to the water provided, one- fourth of the profits were given as a share. On an average, over 20 per cent of the selected farmers were leasing-in land and water for meeting the contractual commitments with the seed companies and this number was on the increase over the years.

Conclusions and Policy Suggestions

The Commercial Seed Production (CSP) of tomato and okra has been found to be highly profitable, by providing a net income of around Rs. 88338/ ha and Rs 39065 /ha, respectively and a total of around 461 and 398 human-days of employment, respectively, to the farmers from dryland farming regions of Haveri and Gadag districts of Karnataka state. Besides the income and employment generation, CSP of tomato and Okra has also enhanced the family welfare through increased income to the family, helping the farmers to reinvest into agriculture, providing better living and health conditions to the family and attaining better status in the society.

At the aggregate level, CSP of tomato and Okra has provided higher income stability in terms of lower coefficient of variation in yield, price and hence income compared to those in the regular dryland crops of the region such as onion, cotton, maize and jowar.

The CSP of tomato and okra has helped reduce the inequality in income distribution more across the farm families as compared to that from the other crops. The Gini's coefficient has also been found lower at 0.28 for CSP compared to other crops. The CSP has provided an opportunity to the growers to derive income maximizing strategies by choosing an optimal combination of CSP of tomato and okra along with other crops.

The success of CSP may be attributed to the symbiotic relation that exists between the growers and the private seed companies. While the seed companies meet their domestic and export need of vegetable hybrid seeds, the farmers realize higher returns and assured employment opportunities. The symbiotic relationship also extends further as the private seed companies recognize their efficiency and honour the growers who obtain the highest seed yield, while the growers organize group meetings to appreciate the efforts of the participating companies.

Policy Implications

There is an urgent need to evolve a national seed production policy that provides guidelines to safeguard environmental and community issues in

commercial seed production programmes involving public-private partnerships. These should include:

- Stringent guidelines and effective watch on the over-exploitation of groundwater and the efforts and incentives for recharging the same.
- Policy guidelines that enforce a commitment for the seed companies to undertake infrastructure development and social welfare programmes for the community where the seed production is undertaken.

Acknowledgements

The authors are grateful to the ICAR for providing funds for this research work, under the Ad-hoc Scheme entitled, 'Assessing the economic impact of selected vegetable technologies on farm income, employment and welfare', and the Director, IIHR, Bangalore for permitting the work to be carried out. The authors are grateful to the anonymous referee for providing valuable comments. The authors also acknowledge the comments and suggestions offered by Dr Mruthyunjaya, National Director, NAIP, which helped in improving the research work and Dr Deshpande and Mr Basava Raju, of Mayhco for their cooperation in data collection. The assistance provided by Smt. C.N. Komala and Mr Kusha Bittira Ullasa, SRFs in the Scheme is also acknowledged.

References

Anonymous, (2004) *Annual Season and Crop Statistics Report*, Directorate of Economics and Statistics, Karnataka.

Verma, Ajay, G. Kalloo, K.P. Singh and M.K. Benerjee, (2002) Production, productivity and export of vegetables, IIVR, *Technical Bulletin* **7:** 6, 13.

Sharma, J.K. and Mukesh Pandey, (2003) Marketing challenges and strategies for promoting Indian vegetable seed industry. *Indian Journal of Agril. Marketing*, **17(1):** 129-153

Sudha, M. and K.V. Subrahmanyam, (1993) Micro and macro level impact of hybrid technology: Case of tomato. Paper presented at the Golden Jubilee Symposium of Horticultural Society of India, ' *Horticulture Research: Changing Scenario*'. May 24-28. Bangalore

Subrahmanyam, K.V. and M. Sudha, (1997) Enhancing the viability of small farms: Diversification through horticultural crops. *Agricultural Situation in India*, **54 (1):** 29-33