

# Ex-post economic impact assessment of vegetable cowpea var. Kashi Kanchan using economic surplus model

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## Abstract

Vegetable cowpea variety “*Kashi Kanchan*” is an improved variety released by ICAR-Indian Institute of Vegetable Research (IIVR) in 2007. This variety is being widely adopted and cultivated by the farmers in different parts of the country. The economic impact of the variety *Kashi Kanchan* is analyzed using Economic Surplus Model (ESM). The results showed that, there was Rs. 111.21 crore of total economic surplus generated of which Rs. 43.81 crore was producer surplus and Rs. 67.40 crore was the consumer surplus. The net profit earned by cultivation of *Kashi Kanchan* variety was Rs. 36406/ac higher than that of local variety grown during rainy season and Rs. 84942 per ac during summer season. The BC ratio was 3.26 for summer crop and 3.04 for winter crop of *Kashi Kanchan* and 1.43 for the local variety. The total estimated area covered under the cultivation of *Kashi Kanchan* variety was 90314.8 ha from 2007-08 to 2019-20 covering a total of 443 districts in 29 states and 2 union territories in the country.

**Keywords:** Vegetable cowpea, Economic surplus, Costs and Returns, Impact assessment

## Introduction

The word ‘Impact’ refers to lasting effect or influence, whereas impact assessment is evaluation of extent of the effect made. Agricultural technologies developed through public funding has been beneficial and shown long term benefits to the

stake holders (Nikam et al. 2019). However, it has become necessary to evaluate the performance of these technologies and their returns to the society and to the economy. In this study, the economic impact of research investments made on the varietal development is analysed. It is an ex-post impact assessment of the variety developed on its performance and economic returns. Cowpea (*Vigna unguiculata*) is grown as a pulse, vegetable, green fodder and cover crop in India. It is rich in proteins, fibre and vitamins required for a healthy human diet. Whereas, farmers growing vegetable cowpea for green pod purpose of consumption has a small scale production in different parts of the country. It is commonly known as yard long bean and serves as an additional income to the farmers growing the crop in mixed or inter or multiple cropping systems (Rajpoot and Rana 2016). The crop has a vigorous indeterminate viny growth which needs a support/staking system for cultivation, restricting it to small scale production. This increases the cost of labour and capital required for its cultivation. The delayed flowering and fruiting habit of this crop due to its longer crop duration do not allow to fit-in the rice-wheat cropping system which is a popular cropping system followed in northern parts of India. Apart from this, the economic yield losses that occur due to cowpea golden mosaic virus disease transmitted by whiteflies and *Pseudosercoospora cruenta* was a major hurdle in choosing this crop for cultivation by the farmers.

**Salient features of the vegetable cowpea variety “Kashi Kanchan”:** To overcome the problems in cultivation of vegetable cowpea, ICAR-Indian Institute of Vegetable Research (IIVR), Varanasi developed a vegetable cowpea variety ‘*Kashi Kanchan*’ in 2007. This variety was recommended for release and cultivation in the agriculture zone IV, V and VII comprising of Punjab, Delhi, Uttar

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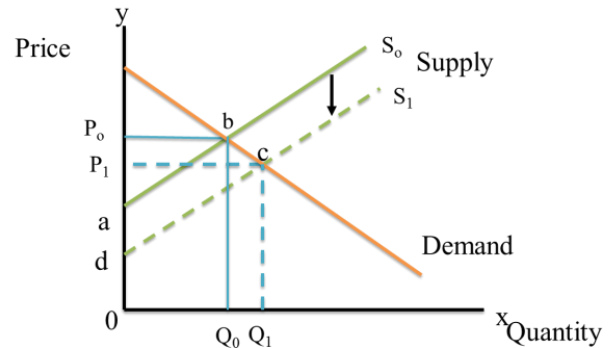
Pradesh, Bihar, Jharkhand, Chhattisgarh, Odisha, Andhra Pradesh, Madhya Pradesh and Maharashtra. Salient features of this variety include resistance to golden mosaic virus and *Pseudocercospora cruenta*. Dwarf and bushy type (height 50-60 cm) of growth due to which cost of cultivation was reduced since no staking/support system was required for the crop. Early flowering (40-45 days after sowing) and early picking of green pods (50-55 days after sowing) had short duration of the crop (70-75 days) which could be grown in between the *kharif - rabi* i.e. rice-wheat cropping system suitable for growing in both spring-summer and rainy seasons (Lal et al. 2016). Pods are about 30-35 cm long, dark green, soft, fleshy and free from parchment. Green pod yield was 150-175 q/ ha. Higher yield of 32% over the check was obtained when released (Singh et al. 2016). With all these qualitative and yield advantages, the variety was released by the institute which was widely adopted and cultivated by large number of farmers all over the country. Hence, an attempt has been made to estimate the ex-post economic impact of the Vegetable cowpea variety *Kashi Kanchan*.

## Materials and Methods

**Estimated area under the variety:** The area cover of the variety was estimated using the quantity of seed sale data from ICAR-IIVR seed sale center. The quantity of truthfully labelled seeds sold to different government and private agencies/farmers were collected from the ICAR-IIVR seed sale center and other private agencies marketing the seeds. Using the seed sale data, the statewise approximate area under the variety was estimated considering the seed rate of 20kg/ha. The data on the quantity of breeder seeds sold to different government and private agencies were collected and further the conversion of breeder seeds to foundation seeds and then to certified seeds was estimated considering the average yield loss (due to biotic and abiotic factors) at 20 per cent and seed multiplication ratio of 1:40. The seed multiplication ratio gives the seed yield in kilogram obtained from 1 kg of seed sown.

**Economic surplus model (ESM):** ESM given by Alston et al. (1995) is generally used to assess the returns on investments made on the research by analyzing the change in consumer and producer

surplus. A closed economy with a parallel supply shift was the assumption made (Figure 1).



Annual gross benefit of research = abcd

## Fig. 1: Impact of research on varietal development

Economic surplus was calculated using the following equations,

Change in producer surplus:

$$\Delta PS = P_0 * Q_0 * (K - Z) * (1 + 0.5Z\eta)$$

Change in consumer surplus:

$$\Delta CS = P_0 * Q_0 * Z * (1 + 0.5Z\eta)$$

Change in total economic surplus:

$$ES = \Delta TS = \Delta CS + \Delta PS \\ = P_0 * Q_0 * K * (1 + 0.5Z\eta)$$

Where,

P<sub>0</sub> = Base price of the commodity

Q<sub>0</sub> = Base quantity

η = Absolute value of the price elasticity of demand

Z = K ε / (ε + η) or the proportionate price reduction in the market, where ε is the elasticity of supply

Kt = Proportionate reduction in cost per ton of production in time t or research induced shift in supply which is given by,

$$K_t = \left( \frac{E(Y)}{\varepsilon} \right) - \left( \frac{E(C)}{1+E(Y)} \right) A t (1-d)^t$$

Where,

$E(Y)$  = Proportionate yield increase per ha for technology adopters

$E$  = Price elasticity of supply

$E(C)$  = Proportionate variable input cost change per ha

$A$  = Proportion of the area under the technology

$d$  = Rate of depreciation of the technology

The Economic impact of the investments made on the research of varietal development was conducted ex-post i.e., after the variety was widely adopted and cultivated by the farmers. Various secondary and primary sources of data were required for the analysis in ESM which has been discussed below.

**Value of increase in yield and change in cost of cultivation:** Primary data from 30 farmers across 5 different villages of Mirzapur and Varanasi districts, Uttar Pradesh were collected by personal interview through pre-tested questionnaires. The data on cost of cultivation, yield, and returns from the farmers who adopted the technology i.e. growing *Kashi Kanchan* variety and the farmers who did not adopt the technology and was growing private or local variety of the crop or both was collected for comparison. The cost of cultivation, net returns and BC ratio was calculated for both *Kashi Kanchan* variety of the crop and the local variety grown in the area. The per cent yield change compared to the local variety grown was estimated to be 0.23. The input cost change was higher because of the staking that is required by the local variety which approximately costs around 24000 Rs/ac including the labour cost. Hence the change in input cost considered was 0.5 (Table 2).

**Elasticity of demand and supply:** The demand elasticity of different agricultural commodities as estimated by Kumar et al. (2011) in which the demand elasticity for vegetables (-0.515) was obtained. The supply elasticity for vegetable cowpea

was assumed to be 0.8 after review of literature of various studies (Benjamin 2012, Chandrashekar et al. 2015, Krishna and Qaim 2007).

**Rate of adoption of the technology:** Upon discussion with the extension scientists, KVK officials and other stakeholders involved in the popularization of the variety, the adoption rate of the technology was assessed and it was also projected for next 5 years to estimate the economic surplus over the period of time. The research & development of the variety started in 2002 and the variety was released in 2007 from when the seed production, distribution, commercialization & popularization of the variety was started leading to its adoption by the farmers all over the country took place.

**Production and wholesale price of vegetable cowpea:** Due to the unavailability of any secondary source of data on vegetable cowpea production in India, the production estimates were calculated using the estimated area under the variety (Table 1). The average wholesale prices of vegetable cowpea was collected from 2002 to 2020 from Agmarknet.com and then converted to the real prices by deflating the figures using the wholesale price index for vegetables for the same period collected from Office of the Economic Adviser, Ministry of Commerce & Industry.

**Probability of success:** It ranged from 0 to 1. Probability of success of the technology was fixed after discussion with the respective breeder and scientists involved in the research, development and extension of the variety. There was less competition by the private seed sector in developing new varieties of this crop and keeping in view the advantages of growing this variety over the locally available varieties of farmers, the probability of success was fixed at 0.8.

**Depreciation factor of the technology:** It means the rate at which the technology depreciates or becomes obsolete. According to the crop breeders, any new variety would last for around 8 to 10 years till an improved variety comes to the market. *Kashi Kanchan* was the ruling variety developed in 2007 up to 2011 until the release of another improved vegetable cowpea variety of IIVR. Accordingly, the depreciation rate of the technology

was considered ranging from 1 to 0.5 over the period.

**Benefit-cost analysis:** A profitability analysis was carried out to show the economic viability of the research using ESM. The most common used parameters such as Net Present Value (NPV), Net Present Benefit (NPB), Net Present Cost (NPC), the Internal Rate of Return (IRR) and the Benefit-Cost-Ratio (BCR) were estimated. The Discount rate considered was 10 per cent to calculate NPV.

Net Present Value (NPV):

$$\sum_{t=0}^n [(B_t - C_t)/(1 + r)^t]$$

Internal Rate of Return (IRR):

$$\sum_{t=0}^n [(B_t - C_t)/(1 + IRR)^t] = 0$$

Benefit Cost Ratio (BCR):

$$\sum_{t=0}^n [(B_t)/(1 + r)^t] / \sum_{t=0}^n [(C_t)/(1 + r)^t]$$

Where,  $B_t$  is benefit (changes in total surplus) in year  $t$ ,  $C_t$  is cost in year  $t$  and  $r$  is the discount rate.

## Results and Discussion

**Estimated area coverage under the cultivation of cv. Kashi Kanchan:** The approximate spread of area under *Kashi Kanchan* variety was estimated at 90314.8 ha (Table 1)

**Table 1:** Total quantity of seed sale (kg) the estimated area (ha) under *Kashi Kanchan*.

S. No.	Particulars	Period (Years)	Total seeds (kg)	Estimated area (ha)
1	Total TL seed sale from IIVR to farmers and other Govt./private agencies	2007-08 to 2017-18	12374.9	618.8
2	Total TL seed sale from private seed company to farmers	2010-11 to 2016-17	612377.5	30618.9
3	Total breed seed sale from IIVR, Varanasi to different Govt./private agencies	2008-09 to 2017-18	1153.9	-
4	Estimated quantity of foundation seeds produced from breeder seeds	2009-10 to 2018-19	36923.2	-
5	Estimated certified seeds produced from foundation seeds	2010-11 to 2019-20	1181542.0	59077.2
	Total	2007-08 to 2019-20	1806294.4	90314.8

Source: Authors' calculations

from 2007-08 to 2019-20 covering a total of 443 districts in 29 states and 2 union territories (calculated from the sale of both TL and breeder seeds data). Around 65% of the estimated total area covered was in Uttar Pradesh and Bihar.

**Estimated cost of the technology, NPV, NPB, NPC, IRR, BCR, PS, CS and ES:** Cost of the technology (*Kashi Kanchan* vegetable cowpea variety in this case) was calculated by the salaries of the scientific and technical personnel involved in the research, development and extension of the technology according to their percent time spent. Besides, laboratory and chemical cost, cost of field trails and multi-location trials, extension cost, cost of seed production and storage and Institutional

charges at 10% was included. The total cost of the technology was Rs. 1.41 crore. However, the variety earned Rs. 24.6 lakh from 2013-14 to 2018-19 under commercialization to 7 different private seed companies as registration fees and loyalty paid to the institute. The estimation results of economic surplus model (ESM) showed that there was producer surplus of Rs. 43.81 crore, consumer surplus of Rs. 67.40 crore and total economic surplus of Rs. 111.21 crore generated from the variety for the last 13 years (Table 2).

The Net Present Value (NPV) generated was Rs.110.45 crore, Net Present Benefit (NPB) was Rs. 111.21 crore and Net Present Cost (NPC) was Rs. 76 Lakhs. The Internal Rate of Return (IRR) was at 82% and Benefit Cost Ratio (BCR) 146.98.

**Table 2:** Economic impact assessment of *Kashi Kanchan* using Economic surplus model

S. No.	Benefit-cost analysis (Rs. crore)	
1	Net Present Value (NPV)	110.45
2	Net Present Benefit (NPB)	111.21
3	Net Present Cost (NPC)	0.76
4	Internal Rate of Return (IRR)	82 %
5	Benefit Cost Ratio (BCR)	146.98
Distribution of Economic surplus (Rs. crore)		
6	Producer surplus	43.81
7	Consumer surplus	67.40
8	Total economic surplus	111.21

**Cost of cultivation and net returns:** The total cost of cultivation of *Kashi Kanchan* variety was Rs. 37518 per ac during summer and Rs. 34067 during rainy season compared to Rs. 76985 per acre of local variety during rainy season. The difference in the cost of cultivation of *Kashi Kanchan* variety over the local variety was mainly due to its short duration

and bushy nature which does not require staking of the crop. The net profit earned was Rs. 36406 higher than that of local variety during rainy season and Rs. 84942 per ac earned during summer season. The BC ratio was 3.26 in summer crop and 3.04 in winter for *Kashi Kanchan* and 1.43 for the local variety grown by the farmers (Table 3).

**Table 3:** Total cost of cultivation and net returns of vegetable cowpea (Rs./ac)

Particulars	<i>Kashi Kanchan</i> variety		Local variety
	Summer	Rainy	Rainy
Variable costs			
Manure	500	500	500
Seeds	1600	1200	320
Fertilizers	1175	1175	1175
Irrigation	1440	480	576
Plant protection chemicals	3200	2400	4800
Staking/training	0	0	20000
Human labour	13612	12084	32354
Machine labour	5280	5280	6080
Interest on working capital (@8%)	2145	1850	3758
Total variable cost	28952	24969	69563
Fixed costs			
Land revenue	27.25	27.25	27.25
Rental value of land	4197	4197	4197
Interest on fixed capital (@8%)	338	338	338
Total fixed cost	4562	4562	4562
Marketing cost	4004	4536	2860
Total cost of cultivation	37518	34067	76985
Average yield (Q/ac)	52	56	44
Average price (Rs./q)	2355	1848	2500
Gross returns	122460	103488	110000
Net returns	84942	69421	33015
BC Ratio	3.26	3.04	1.43

## Conclusion

Vegetable cowpea variety *Kashi Kanchan* has many advantages over the other local varieties. It is the first bushy type of variety released by ICAR-IIVR which does not require staking or support for the crop which saved the cost of labour and capital (Rs. 24000/acre) required for staking of the crop. The net profit earned by cultivating *Kashi Kanchan* was Rs. 36406/ac higher than cultivation of local variety. Returns to the research investment made were Rs. 110.45 crore. The total economic surplus generated

due to the variety was 111.21 crore adopted and grown in different parts of the country.

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सारांश

भा.कृ.अनु.प.—भारतीय सब्जी अनुसंधान संस्थान द्वारा 2007 में जारी की गई लोबिया की सब्जी किस्म 'काशी कंचन' एक उन्नत किस्म है। देश के विभिन्न हिस्सों में किसानों द्वारा इस किस्म को व्यापक रूप से अपनाया और इसकी खेती की जा रही है। आर्थिक अधिशेष मॉडल (ईएसएम) का उपयोग करके काशी कंचन किस्म के आर्थिक प्रभाव का विश्लेषण किया गया है। परिणामों से पता चला कुल आर्थिक अधिशेष का 111.21 करोड़ रुपये थी। रु. 43.81 करोड़ उत्पादक अधिशेष और रु. 67.40 करोड़ उपभोक्ता अधिशेष था। काशी कंचन किस्म की खेती से अर्जित शुद्ध लाभ रुपये। 36406 प्रति एकड़ बरसात के मौसम में उगाई जाने वाली स्थानीय किस्म से अधिक और गर्मी के मौसम में रु. 84942 प्रति एकड़ थी। काशी कंचन की ग्रीष्मकालीन फसल के लिए बीसी अनुपात 3.26 और शीतकालीन फसल के लिए 3.04 तथा स्थानीय किस्म के लिए 1.43 रहा। 2007–08 से 2019–20 तक काशी कंचन किस्म की खेती के तहत कुल अनुमानित क्षेत्र 90314.8 हेक्टेयर था, जिसमें देश के 29 राज्यों और 2 केंद्र शासित प्रदेशों के कुल 443 जिले शामिल थे।

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