Journal of Cereal Research
Volume 16 (2): 184-192
Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Research Article

Impact assessment of improved wheat variety VL Gehun 907 in Uttarakhand using economic surplus approach

Amit Thakur*, Kushagra Joshi, Janvi Kochar and Lakshmi Kant

ICAR VPKAS Almora, Uttarakhand, India

Article history:
Received: 10 Apr., 2024
Revised: 29 Nov., 2024
Accepted: 11 Dec., 2024

Citation:
Thakur A, K Joshi, J Kochar and L Kant. 2024. Impact assessment of improved wheat variety VL Gehun 907 in Uttarakhand using economic surplus approach. *Journal of Cereal Research* ***16 (2):*** *184-192. http://doi.org/10.25174/2582-2675/2024/150499*

***Corresponding author:**
E-mail: amitthakur5920@gmail.com

Abstract

Economic benefits of adopting an improved rust-resistant variety, VL *Gehun* 907, of wheat in the hill districts of Uttarakhand have been examined. At the field level, variety had a 20-25 per cent yield advantage. The variety adoption was assessed through certified seed demand, which varied from 3 per cent to 27 per cent in the hill region and substantially contributed to wheat production. The economic surplus approach was used for assessing the impact of the high-yielding, rust-resistant variety suitable for rainfed and irrigated timely sown conditions of hills. The estimation approaches, Ex-ante and ex-post, were employed for surplus calculations. At the aggregate level, the ex-post method supplemented with information on adoption rate and output growth, accurately estimates benefits. The total benefits accrued from the investment over nine years amounted to 251 crores. These results speak to reorienting agricultural research to consider the challenges of hill farmers and develop as well as disseminate a higher number of improved varieties suitable for hills to enhance farmers' socio-economic status and overall agriculture development.

Keywords: Improved variety, wheat, yield benefits, economic surplus

1. Introduction

Wheat holds a central position in the global agro-food system (Erenstein et al., 2022), covering 218 million hectares and serving as a staple crop for 40 per cent of the population, providing 20 per cent of daily calorie and protein intake (Acevado et al., 2018; Sendhil et al., 2012; Shiferaw et al., 2013). Technological breakthroughs in wheat breeding have significantly boosted productivity to 3.5 tonnes per hectare and facilitated access to diverse regions worldwide. Institutional approaches have played a crucial role in mainstreaming wheat consumption, leading to substantial achievements in food and nutritional security (Sendhil et al., 2018; Grote et al., 2021).

The transformation of Indian agriculture from food deficit to food exporter owes much to the "Green Revolution" marked by the adoption of high-yielding varieties, fertilizers, chemical inputs, and irrigation, which scaled up the production and productivity of food grains, primarily rice and wheat. Wheat productivity in India has increased from 1 tonne per hectare to 3.5 tonnes per hectare between 1964-65 and 2021-22. Over the past five decades, wheat production and area have witnessed significant increase of 275.05% and 120.23%, underlining India's journey towards self-sufficiency in food grain production and ensuring food security for a significant portion of its population (Sendhil et al., 2018).

In developing nations, wheat is the most widely cultivated and consumed food crop, with these regions harvesting 50 per cent of global wheat production across 53 per cent of the cultivation area. In India, wheat cultivation spans 31.8 million hectares, making it the second-largest producer globally with an output of 112.8 million tonnes (GoI, 2022). The demand for wheat has doubled in the last four decades, especially in developing regions. However, fulfilling this demand is challenged by rising population, changing climate scenarios like extreme heat events, increasing biotic and abiotic stress, and decreasing natural resource bases like land and water. (Yadav et al., 2010; Sendhil et al., 2022). These challenges highlight the need for continuous development of elite germplasm specifically tailored to the needs of developing countries to ensure sustainable wheat production.

The factors underlying the superfluous growth of the wheat economy are public-funded research, excellent breeding programs such as the All India Coordinated Project on Wheat (AICRP), agricultural price policies, and institutional interventions (Singh et al., 2019; Sendhil, 2019; Thakur et al., 2022). However, the gains from wheat production are unevenly distributed, with the majority concentrated in the plains, particularly the North Western Plains (NWPZ), which account for over 40 per cent of the area and 60 per cent of production (Gupta & Kant, 2012; Sharma et al., 2015).

While wheat performance is relatively strong in regions like the North Western Plains and the Central Zone, productivity remains low in the North Hills Zone (NHZ), covering hilly parts of UT's of J&K and Laddakh and states of Himachal Pradesh, Uttarakhand, Sikkim and part of West Bengal, averaging 2 tonnes per hectare compared to the national average of 3.5 tonnes per hectare. In the NHZ, Uttarakhand exhibits high wheat productivity at 2.8 tonnes per hectare, followed by J&K at 1.9 tonnes per hectare and Himachal Pradesh at 1.7 tonnes per hectare (GoI, 2022). However, productivity varies significantly between hill and plain regions within NHZ. For instance, in Uttarakhand, wheat productivity varies nearly threefold between hills (1.5 tonnes per hectare) and plains (4.2 tonnes per hectare) (GoU, 2021).

The lower productivity observed in Uttarakhand's hilly regions is due to multiple factors. Prolonged vegetative growth followed by reduced grain-filling period, the semi-temperate climate, quality seeds unavailability, dependence on rain-fed systems, absence of machinery suitable for small fields, poor extension linkages for technology transfer, and prevalence of biotic stresses such as rust, loose smut and bunt problems (Kant, 2006; Gupta & Kant 2012; Jethi et al., 2020). Moreover, farmers in high-altitude areas often rely on local varieties susceptible to various rust pathotypes, which challenges wheat production (Kant et al., 2020).

The challenges of topography and environment have revamped breeding programs to cater to the specific needs of hill farmers. A series of new semi-dwarf wheat varieties with high yield potential, disease resistance, and drought tolerance were released to enhance production and productivity in hilly terrain (Gupta & Kant, 2012). In this context, the Indian Council of Agricultural Research-Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR VPKAS) in Almora has played a pivotal role in the development and dissemination of improved wheat varieties tailored to withstand biotic and abiotic stresses prevalent in the high hill rainfed agriculture of the North Hills Zone (NHZ). Notably, the release of the VL *Gehun* 907 wheat variety in 2010 was designed to combat yellow and brown rust diseases while also augmenting nutritional quality with its high iron content. Numerous micro-level experimental studies on VL *Gehun* 907 conducted under varied environmental conditions and trials have consistently displayed superior performance over other varieties (Bisht et al., 2018; Kumar et al., 2016; Pathania et al., 2019). However, literature on institutional research's macro-level impact, particularly concerning varieties performance, remains limited for the NHZ region. Hence, this paper adds to the literature by conducting an economic impact assessment of the VL *Gehun* 907 wheat variety in the hilly areas of Uttarakhand.Through this study, we analyze how investments in breeding research for the development of high-yielding, disease-resistant varieties can significantly generate surpluses for producers and consumers in hilly regions.

2. Material and Method

2.1 The study region

Wheat cultivation in Uttarakhand covers 0.32 million hectares, with approximately 44 per cent of this area in the hills. However, despite its sizable acreage, the hill regions contribute only 22 per cent to the total wheat production. This stark contrast is primarily attributed to the inherent challenges faced by hill agriculture, including climate variability characterized by low and erratic rainfall, limited irrigation facilities, scarcity of quality seeds, and rust infestations. Despite these challenges, wheat productivity has improved across Uttarakhand's plains and hills. Over the decade from 2009-10 to 2020-21, wheat productivity in the plain region surged from 3.3 to 4.2 tonnes per hectare. Similarly, in the hilly terrains, productivity increased from 1.13 to 1.54 tonnes per hectare during the same period.

Wheat variety VL *Gehun* 907 was released in 2010 and introduced into the Uttarakhand government's seed supply chain for quality seed production and distribution. Since then, it spread throughout the state, given the rise in the demand for certified seed. In this paper, we have estimated the benefits derived from this variety in the hill region of the state.

2.2 Method of analysis

The methods to quantifying the economic benefits of a technological change have advanced and turned more specific with time (Birthal et al., 2012). The economic surplus approach is widely used in assessing the impacts of technology at the macro level in particular. This approach offers flexibility and requires minimal data for estimation. The ex-ante approach helps assess the potential benefits of introducing new technology. However, the estimation of benefits at the beginning requires assumptions regarding its rate of adoption spread throughout, which can vary in actual cases and may lead to a less precise estimation of the benefits. This paper employed an ex-post economic surplus approach to estimate the net benefits of adopting wheat varieties. We introduced certified seed demand of the variety as a proxy for varietal adoption for the ex-post surplus estimate. We compared it with the ex-ante approach, where the adoption rate was based on the breeder's estimates of technology performance. Figure 1 illustrates the downward supply shift due to the introduction of a yield-increasing variety, from S0 to S1; assuming demand remains unchanged at D. The price of wheat is determined by the market at P_0 and subjected to the variations mainly due to the domestic production and policy changes. Economic surplus generated through improved yield is shared among the producers and consumers. We preferred the closed economy model for the current study given the low production and no trade to other regions from hills.

Closed economy model:

Economic surplus model is calculated using the following formula:

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

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

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

Where,

P_0 = Base price of the commodity Q_0 = Base quantity,

η = Absolute value of the price elasticity of demand

$$Z = K \frac{\varepsilon}{\varepsilon + \eta}$$

Z is the proportionate price reduction in the market, where ε (epsilon) is the elasticity of supply

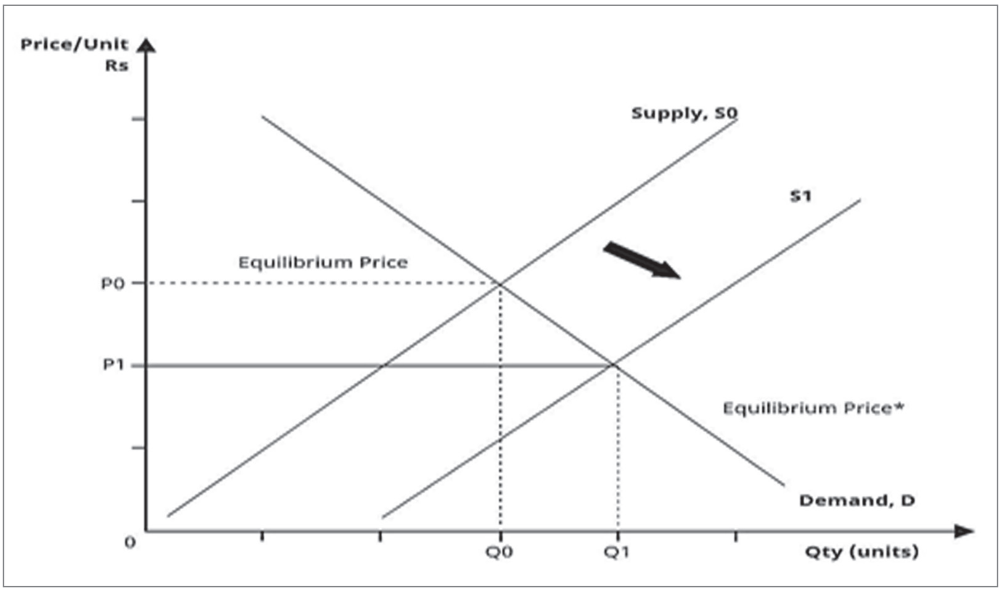

Fig 1: Economic surplus model in a closed economy framework

K= Proportionate reduction in cost per ton of production in time t or research induced shift insupply and it can be calculated as

Where,

$$K(t) = \left(E(Y)/_{\varepsilon}\right) - \left(E(C)/_{1+E(Y)}\right) A_t (1-d)^t$$

E(Y) = Proportionate yield increase per hectare for technology adopters ,

E(C) = Proportionate variable input cost change per hectare,

A = Proportion of the area affected by the technology,

d = Depreciation rate of the technology (Alston et al., 1995),

2.3 Risk Benefits

Benefits from reduction in yield variance due to adoption of disease resistant varieties have been estimated using the Newbery-Stiglitz approach. Reduction in yield variance benefits the risk-averse producers and influence income distribution (Kostandini et al., 2009). The method is outlined below:

Let, Y_0 be the mean yield and σy_0 be its coefficient of variation for the old variety. Adoption of a disease tolerant variety changes mean yield to Y_1 and the coefficient of variation to σy_1. The benefits due to change in variance in yield then can be estimated using

$B/Y0 = 0.5\ R\ (\sigma y1 - \sigma y0)$

Where, B represents the monetary benefits due to change in reduction in yield variance, R is the risk aversion coefficient.

2.4 Data Requirements

Agriculture Statistics Department, Directorate of Agriculture, Uttarakhand website (https://agriculture.uk.gov.in/pages/show/221-agriculture-statistics-data) used for the data on the area, production and productivity of wheat in hill region. For the elasticity values, we used study by Kumar et al. (2011). Certified seed demand for the variety was assessed from Seed Net Portal of GoI (https://seednet.gov.in/).

3. Results

Table 1: Growth and variability in wheat production in Uttarakhand

	Plain (<600-meter height)						**Hill Region (>600-meter height)**					
Parameters	**Area**		**Production**		**Yield**		**Area**		**Production**		**Yield**	
	2000 to 2010	**2011 to 2021**	**2000 to 2010**	**2011 to 2021**	**2000 to 2010**	**2011 to 2021**	**2000 to 2010**	**2011 to 2021**	**2000 to 2010**	**2011 to 2021**	**2000 to 2010**	**2011 to 2021**
Annual Growth Rate (%)	0.8	-0.3	2.3	0.56	1.52	0.59	-0.9	-4.3	1.3	-1.7	2.2	2.7
Coefficient of variation (%)	4	1.42	11	11.1	8	10.5	4.05	15.8	15.4	13.22	13.2	16.8

Source: Estimated by the author.

Wheat production in the plains of Uttarakhand recorded a positive annual growth rate of 2.3 per cent during 2000-10, which decelerated to 0.56 per cent during 2011-21 (Table 1). In the first period, production occurred due to the expansion in area and yield; however, in the second period, yield improvement was solely responsible for increased production. The deceleration in growth was followed by an increase in variability.

In the hills, during the first period, production growth of 1.3 per cent per annum was observed, whereas it decreased by 1.7 per cent per annum in the second period. The coefficient of variation of cultivated area in hills increased from 4.05 to 15.8 during two periods. The decline in the wheat area in the hills is the major reason for reduced production in the second period. However, the yield has registered a positive annual growth rate of more than 2 per cent in both periods, indicating the introduction of improved varieties in the hills.

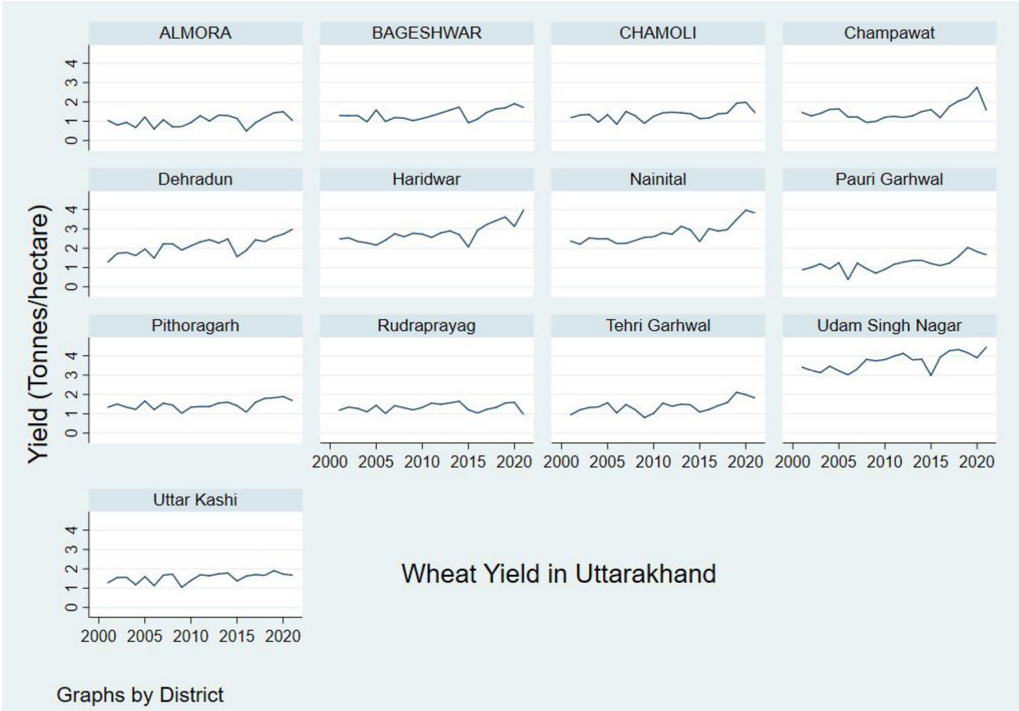

Fig 2: District wise wheat yield in Uttarakhand

Fig 2: illustrates an upward trajectory in yield (measured in tonnes per hectare) across the plains encompassing areas such as Haridwar, Dehradun, Udham Singh Nagar, and Nainital. Conversely, the hilly regions do not exhibit a consistent pattern of growth in yield.

Wheat cultivation areas witnessed a decrease in several hill districts, including Champawat, Pauri Garhwal, Tehri Garhwal, Pithoragarh, Uttarkashi, Almora, and Dehradun as depicted in figure 3. In plains, Udham Singh Nagar experienced an increase; however other districts Haridwar, Chamoli, and Nainital showed no significant changes in their wheat cultivation areas.

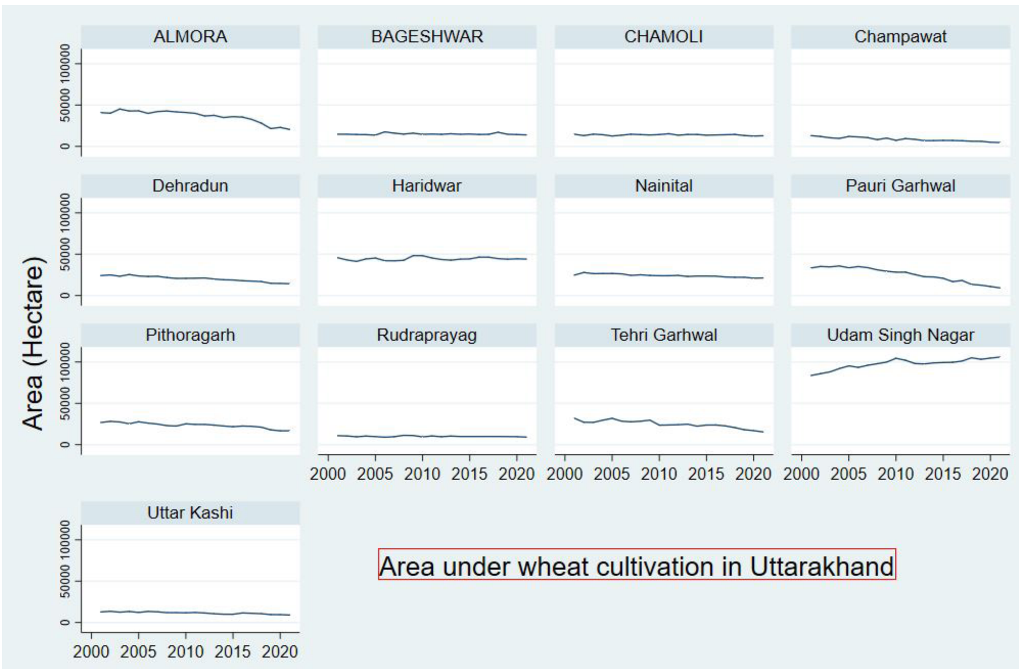

Fig 3: District wise acreage under wheat crop in Uttarakhand

3.1 Seed Replacement Ratio (SRR): Seed replacement rate represents the fresh quality seed required for the replacement of the old seed every year. The trend for quality seed production and demand is positive for both hills and plains. SSR of wheat for hills has increased to 26.8 per cent from 20 per cent during 2009-2021; indicating rising share of the quality seed in hills. However, for the plains SRR remains near to 50 per cent, a major booster of the production and productivity in the plains.

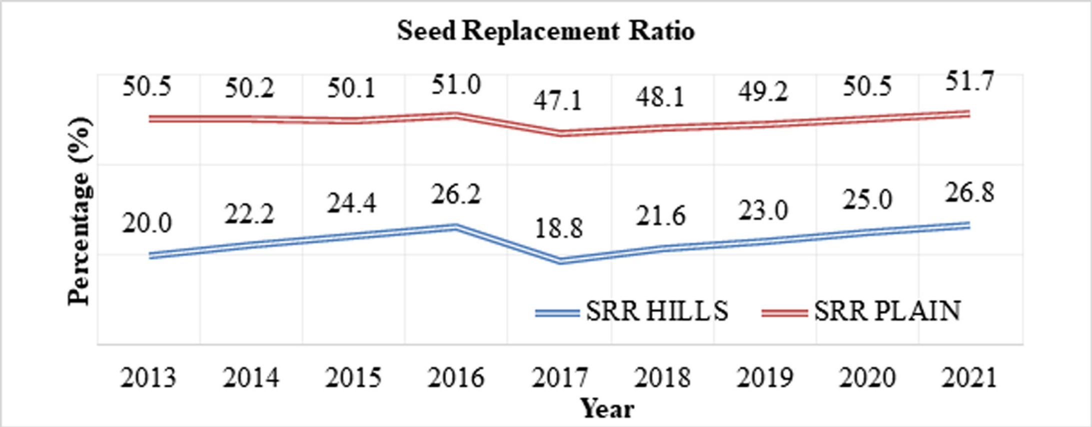

Fig 4: Seed replacement ratio in hills and plains of Uttarakhand

3.2 Demand of the variety: Using the data on certified seed requirement of wheat in hills, demand of VL *Gehun* 907 increased significantly from 12 tonnes to a maximum of 80 tonnes during 2013-2021. This information is critical to navigate the changes in the share of variety in focus and competition from new varieties to estimate the adoption and impact accurately.

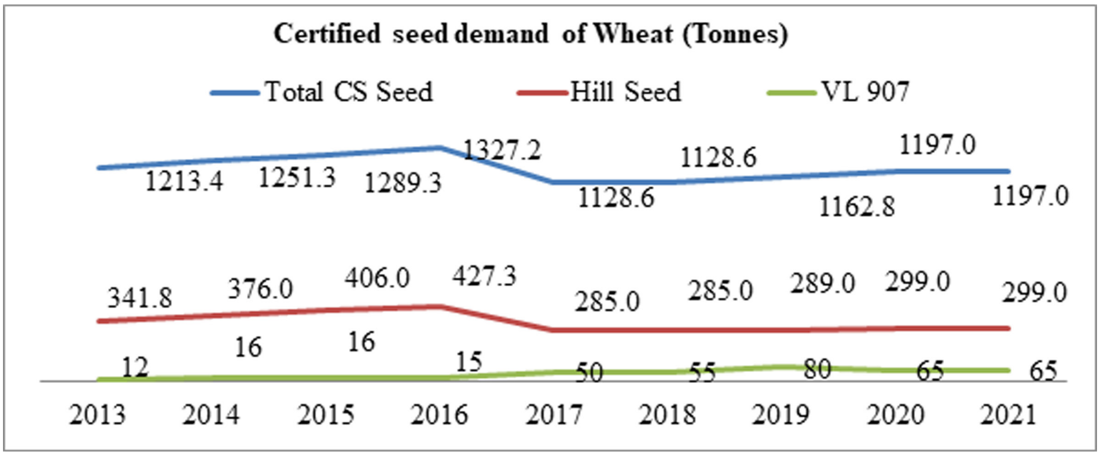

Fig 5: Certified seed demand of wheat crop in total, in hill region and VL *Gehun* 907 variety

3.3 Area under the variety and yield variability: In the ex-ante approach, information on the variety's performance based on breeder's expectation and experience may lead to less precise estimates of the surpluses. In our ex-post impact assessment, we utilized the certified seed demand data for calculation of the possible adoption of the variety.

Figure 6 represents the share of VL *Gehun* 907 variety in the certified seed demand in hills and in total. In hills, share of VL *Gehun* 907 varied from 3.5 per cent to 27 per cent of total certified seed demand during 2013-21. This is useful in estimating the economic surpluses more precisely by including a varied adoption rate rather than relying on a single estimate of the adoption.

Variable yield improvement [E(Y)], is generally constant in ex-ante studies. In our ex-post study, yield data obtained from the field trial in different years is used. For the initial years, variety performed well with high yield (20%) and declined in later years (15%).

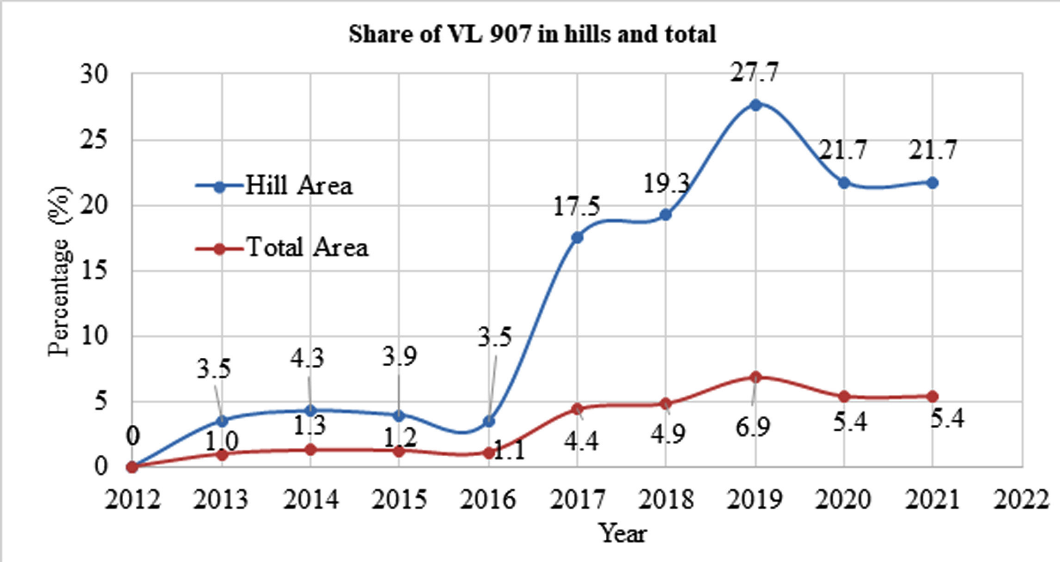

Fig 6: Share of the VL *Gehun* 907 certified seed demand in hills and total

Table 2: Assumptions followed in the economic surplus calculations

Variable	Parameter Value		Remarks
	Ex-ante method	Ex post method	
Demand elasticity	0.21	0.21	Kumar et al., 2011
Supply elasticity	0.34	0.34	Kumar et al., 2011
Yield change (%)	10	10-15	Data for yield change is taken from the field survey and demonstrations
Adoption Rate (%)	10	27.7	Varied adoption rate is used in surplus calculations
Adoption period (time to maximum/ceiling adoption level (years)	3-4	7	Variety reached the maximum adoption at 7th year
Output growth factor $(g_o = g_{a+} g_y)$	3%	-2.7%	We considered the yield and output growth for the study period (2013-2021)
Price (Rs./tonne)	13610	13610-19520	Price changes during the years (2013-2021) are included.

3.4 Output and price changes: Economic surplus method requires an exogenous growth factor for subsequent year output. The factor is sum of the area and yield growth in past years and project for future output, termed as without research quantity. This factor is generally positive based on the past trends. However, the output trend can vary with time in either direction depending on several factors. In our study, wheat output registered a negative trend for the hills and we used the negative factor for the exogenous output variable calculation (Table 2).

Price variable in the ex-ante estimation is constant as base year price; however, the prices variations due to policy changes need to be accounted for the surplus estimation. In our study, we used the current year prices for surplus estimation (Table 2).

Impact generated by the variety VL *Gehun* 907, utilizing the ex-ante approach through the information from breeders on the expected performance of the variety, estimated the total aggregated surplus of 149.72 crores. However, in ex post approach we considered the negative growth factor, varied adoption rate and current prices, hence the aggregate benefits obtained is 251.18 crore. IRR calculations in case of ex post studies is 149 per cent whereas in ex-ante it is 173, which indicates the

Table 3: Aggregate benefits from the adoption of VL *Gehun* 907 (in Crore)

Parameter	Ex-ante	Ex post
Consumer Surplus	57.30	96.71
Producer Surplus	90.02	152.07
Yield Benefits	2.40	2.40
Total Surplus	149.72	251.18
NPV @ 3%	114.78	185.40
IRR (Internal Rate of Return %)	173	149

Source: Estimated by the author.

overestimation of the returns derived from the investment in breeding research. Using the modified version, ex-post method revised the estimates from the research. NPV (Net Present Value) is higher for the ex post study, as we accounted the actual varietal adoption. The results justify the research investment that produced the crop variety VL Gehun 907.

Conclusion

Investment in breeding research is essential in developing new technologies especially improved varieties that are capable of transforming the agriculture productivity and farmers' welfare. Knowledge of the varietal impact at field level is essential in determining the returns from investment. In the present paper, we analyzed the impact of VL *Gehun* 907 wheat variety in the hills of Uttarakhand. We utilized the certified seed demand data for estimation of surpluses. The adoption ranges between 3.5 to 27.7 per cent, yielding a total net benefit of 185.40 crore through the ex-post method, accompanied by an internal rate of return of 149 per cent. Share of consumer surplus is on higher side than producer surplus. Along with ex post approach, we compared the results obtained from the ex-ante analysis, found that the inclusion of information on certified demand of variety affects the returns, and can be calculated more accurately. Along with this, surplus generated by the variety are substantial which calls for more investments in the agriculture research in hills in terms of varietal development for coping with biotic and abiotic stress in future.

Author contributions

All authors contributed equally for preparing final vesrion of the mansucript.

Conflict of interest

No

Declaration

The authors declare no conflict of interest.

References

1. Acevado M, JD Jurn, G Molero, P Singh, X He, M Aoun, P Juliana, H Bockleman, M Bonman, M El-Sohl, A Amri, R Coffman& L McCandless. 2018. The role of wheat in global food security *In, Agricultural Development and Sustainable Intensification: Technology and Policy Challenges in the Face of Climate Change.*
2. Birthal PS, SN Nigam, AV Narayanan & KA Kareem. 2012. Potential Economic Benefits from Adoption of Improved Drought-tolerant Groundnut in India. Agricultural Economics Research Review, 25(1), 1-14.
3. Bisht A, SK Lavania, PK Singh & YP Singh. 2018. Study the comparative yield and yield attributes of wheat (*Triticum aestivum* L.) Under open and Populus based agroforestry system. Journal of Pharmacognosy and Phytochemistry, 7(1), 1161-1167.
4. Erenstein O, M Jaleta, KA Mottaleb, K Sonder, J Donovan & HJ Braun. 2022. Global Trends in Wheat Production, Consumption and Trade. In: Reynolds, M. P., Braun, H. J. (Eds.), *Wheat Improvement*. Springer.
5. GoI. 2022. Agricultural Statistics at a Glance. Ministry of Agriculture & Farmers Welfare, Department of Agriculture & Farmers Welfare, Economics & Statistics Division, New Delhi. https://

desagri.gov.in/wp-content/uploads/2023/05/Agricultural-Statistics-at-a-Glance-2022.pdf

6. GoU. 2021. Agriculture Statistics of Uttarakhand. Agriculture Statistics Department, Directorate of Agriculture, Uttarakhand. https://agriculture.uk.gov.in/pages/display/224-department-structure

7. Grote U, A Fasse, TT Nguyen & O Erenstein. 2021. Food Security and the Dynamics of Wheat and Maize Value Chains in Africa and Asia. *Frontiers in Sustainable Food Systems,* 4, 617009.

8. Gupta HS & L Kant. 2012. Wheat Improvement in Northern Hills of India. Agric. Res, 1(2), 100-116.

9. Jethi R, L Kant, BR Raghu & NC Gahtyari. 2020. Economic Impact of High Yielding Rust Resistant Wheat Varieties Suitable for Hill region of Uttarakhand. *Journal of Cereal Research*, 12(2), 142-149.

10. Kant L. 2006. Approaches to improvement in wheat and Barley productivity. In H. S. Gupta, A. K. Srivastva & J. C. Bhatt (Eds.), *Sustainable production from agricultural watersheds in NWH*. VPKAS, Almora, pp 139–151.

11. Kant L, SK Pant, SK Jain, BR Raghu, BD Pandey, D Shankar, D Mahanta, R Jethi, A Pattanayak, GS Bankoti & LD Malkani. 2020. VL *Gehun* 953: A high yielding, rust-resistant, winter x spring wheat (*Triticum aestivum* L.) derivative, suitable for organic hills as well as inorganic Plains of Uttarakhand state of India. *Journal of Cereal Research*, *12*(1), 40-43. *Agricultural Economics,* 40, 477-492.

12. Kostandini G, BF Mills, SW Omamo & S Wood. 2009. Ex ante analysis of the benefits of transgenic drought tolerance research on cereal crops in low-income countries. *Agricultural Economics*, 40: 477-492.

13. Kumar P, A Kumar, S Parappurathu & SS Raju. 2011. Estimation of Demand Elasticity for Food Commodities in India. *Agricultural Economics Research Review*, 24(1), 1-14.

14. Kumar S, S Archak, RK Tyagi, J Kumar, V Vk, SR Jacob, K Srinivasan, J Radhamani, R Parimalan, M Sivaswamy, S Tyagi, M Yadav, J Kumari, S Deepali Sharma, I Bhagat, M Meeta, NS Bains, AK Chowdhury & KC Bansal. 2016. Evaluation of 19,460 Wheat Accessions Conserved in the Indian National Genebank to Identify New Sources of Resistance to Rust and Spot Blotch Diseases. *PLOS ONE*, *11*(12), e0167702.

15. Pathania R, R Prasad, RS Rana & SK Mishra. 2019. Heat unit requirement and yield of wheat (*Triticum aestivum* L.) varieties under different growing environment in mid hill conditions of Himachal Pradesh. *Journal of Agrometeorology,* 21(3), 282-287.

16. Sendhil R, R Singh & I Sharma. 2012. Exploring the Wheat performance in India. *Journal of Wheat Research*, 4 (2); 37-44.

17. Sendhil R, A Jha, A Kumar & S Singh. 2018. Extent of vulnerability in wheat producing agro-ecologies of India: Tracking from indicators of cross-section and multi-dimension data. *Ecological Indicators*, *89*, 771–780.

18. Sendhil R, KTM Kumar & GP Singh. 2019. Wheat Production in India: Trends and Prospects. Intech Open. doi: 10.5772/intechopen.86341.

19. Sendhil R, B Kumari, S Khandoker, S Jalali, KK Acharya, K Gopalareddy, GP Singh and AK Joshi. 2022. Wheat in Asia: Trends, Challenges and Research Priorities. In: Kashyap P.L. et al. (eds) New Horizons in Wheat and Barley Research. Springer, Singapore. https://doi.org/10.1007/978-981-16-4449-8_3

20. Sharma I, R Sendhil & R Chatrath. 2015 August 21-24. Regional Disparity and Distribution Gains in Wheat Production. Paper presented at 54th All India Wheat & Barley Research Workers' Meet, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

21. Singh GP, R Sendhil & P Jasrotia. 2019. AICRP on Wheat and Barley: Salient Achievements and Future Directions. *Indian Journal of Fertilizers,* 15(4), 80-90.

22. Thakur A, P Ray, KK Acharya, A Das, R Jaiswal, U Ravishankar & R Sendhil. 2021. Price dynamics in Indian wholesale wheat markets: Insights and implications. *The Indian Journal of Agricultural Sciences*, 91(8), 1219-1225.

23. Yadav R, SS Singh, J Neelu & GP Singh. 2010. Wheat Production in India: Technologies to Face Future Challenges. *Journal of Agricultural Science,* 2(2), 164-173.