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Investment on wheat research and its effect: A case of Nepal

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Abstract. *Although the agriculture sector markedly contributes to the Nepalese economy, very little is known about the government's investments in agricultural research activities and how these investments have impacted the sector. In this study, we picked a case of wheat crop as it is the third largest crop of Nepal in terms of total annual production. We took government's annual wheat research investments of Nepal from Fiscal year 2005 to 2016 to analyze the effects of investment on wheat research based on the availability of data. We used compound growth rate, averages, trend line, and bar diagram to present the data and interpret the results. Results revealed that the share of operational budget was lower than supposed to be allocated for the development of wheat research. The pace of increment of wheat production and productivity were observed due to improved wheat investment and technologies. Result shows the negligible spillover effect from neighboring countries in wheat production. Even though the Nepal Agricultural Research Council (NARC) has fulfilled source seed target by producing a surplus, private sectors should involve proactively in coordination with NARC to meet the projected demand of wheat seed in national seed vision. The huge gap was observed between yield potential and average national productivity. To achieve greater impact of wheat research in Nepal, it is necessary to bridge the gap by awareness program, making the availability of improved seed with an improved package of practices.*

Keywords: bridging gap, wheat varieties, government research investment, technological progress

Abbreviations: GDP- Gross Domestic Production; NARC- Nepal Agricultural Research Council; MoAD- Ministry of Agriculture Development; GoN- Government of Nepal; FAOSTAT- Food and Agriculture Organization Corporate Statistical Database; CGR- Compound Growth Rate; CBOs- Community-based organizations; ABD- Agriculture Botany Division.

Introduction

Although agriculture sector stands as principal contributor to national gross domestic production (GDP), the sector does not get sufficient proportion of investments as it requires. Of the total national budget, the percentage of agricultural research and development investment was 2.41% in 2005 and 3.29% in 2016 (NARC, 2005 and 2016). Similarly, the investment in agricultural research was only 0.28% of the total national budget in 2005, which is further reduced to 0.25% in 2016 (NARC, 2004-2016). Ministry of Agriculture and Development (MoAD) has allocated 11.56% of its budget to agricultural research in 2005, which is reduced to 7.73% in 2016.

Studies have illustrated that expending in agricultural researches will have a positive impact in both short-run and long-run (Alaston et al., 2000; Fatima et al., 2017). Moreover, it also contributes to alleviate poverty (Kerr and Kolavalli, 1999; Fan et al., 2000). Agricultural research is a continuous process which is intended to improve the well-being of producers and consumers by minimizing costs, increasing output, improving product quality and/or introducing new products (Shrestha and Gairhe, 2016). Paudyal and Khatiwada (2013) highlighted the measures to be taken in Nepal for the improvement of research more vibrant and output-oriented by commodity-based consolidated planning with specified role and responsibility, technological verification and up-scaling in major agro-ecological situations, technology registration and user friendly publications, technology linkup with commodity and organizations and industries, appropriate human resource planning, strong technical monitoring, and judicial resource allocation. Gairhe et al. (2017) reported that budget increment is not only the factors that were related to the output of the research but it also requires competent human capital in required number with specific knowledge. Gairhe and Acharya (2017) stated that the low investment in fruit research and less number of human capital has affected the technology generation and out-scaling to the farmer.

Wheat is the third most important crop after rice and maize in Nepal; it's cultivated in 762 373 hectares with an average national yield of 2.55 t/ha (MoAD, 2017). In Nepal, National wheat research program, regional agricultural research stations, different disciplinary divisions under Nepal Agricultural Research Council (NARC) are mandated to develop wheat varieties and wheat-related technologies. High yielding variety of wheat called Lerma 52 was the first crop variety released in Nepal in 1960 (GoN, 2013). Since then until 2017, Government of Nepal has released 43 improved wheat varieties of which 13 varieties are de-notified (Timsina et al., 2018a). Gauchan and Pandey (2011) reported substantial underinvestment in rice research (and agriculture research in general) in Nepal. In wheat, the rate of change in wheat productivity was highly significant due to much improved technologies adopted by farmers (Thakur et al., 2007). Attractive

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rates of return to investment in wheat breeding have been reported in Nepal due to Nepal's ability to capture spillover benefits from neighboring countries and from international agricultural research centers (Morris et al., 1994). Therefore, to find out the effect of wheat research investment in Nepal in recent years, this study was designed by taking wheat as case over the past one decade based on the availability of data only for that period.

Material and methods

Data sources

The study was based on secondary data from FAOSTAT websites, statistical information of Nepalese agriculture from MoAD, published and unpublished sources from planning, monitoring, and evaluation division of Nepal Agricultural Research Council. The data on an/the operational budget of wheat and other crops; numbers of wheat projects, and total projects of NARC; area under wheat cultivation, its productivity, and production; target of various wheat seeds (breeder and foundation) and their achievements; released wheat varieties of study period from 2005 to 2016 were collected. The study employed the compound growth rate, for the analysis of the data. Trend lines, bar diagrams were also used for the presentation of the data. The study has some limitations, as the study was unable to include capital, administration and researchers involvement in wheat research.

Compound Growth Rate (CGR)

Compound growth rate (CGR) of the area, production, and productivity of wheat; total operational budget of NARC, total operational budget of crops research wheat operational budget was calculated over the past decade based on data availability. The growth of any variable indicates its past performance. The analysis of growth is usually used in economic studies to determine the trend of a particular variable over a period of time. As it indicates the performance of the variable under consideration, it can be used to make interpretations and to evolve policy decisions (Timsina et al., 2015). The CGR can be calculated as:

$$CGR\ (Yt) = a \cdot b^t \cdot u_t, \quad (1)$$

Where:

Y_t = dependent variable for which growth rate was estimated;

a = intercept;

b = regression coefficient (1 + g), where g is the compound growth rate;

t = years which takes values, 1, 2, …, n;

u_t = disturbance term for the year t.

This study used Ordinary Least Square (OLS) through transforming dependent variable into logarithmic form while keeping all the variables on the right-hand side of the equation 1. The compound growth rate (g) in percentages (%) was then computed from the relationship:

$$g\ (\%) = \{\text{Antilog of } (\ln b)\text{-}1\} \times 100 \quad (2)$$

The significance of the regression coefficient was tested using the student's test (Gujrati, 1999; Gaire et al., 2011; Timsina et al., 2015).

Results and discussion

Government expenditure on agricultural research has climbed substantially over the past few years. As operational budgets are only the actual expenditure that is used for the research interventions, this study fully relies on the operational budget of NARC from the fiscal year 2005 to 2016. As shown in Table 1, total operational investment in agricultural research by NARC has reached NRs 587265 in 2016 from 105089 in 2005 (1USD = 105.371 NRs in 2016 and 1USD = 71.49 NRs in 2005). Although the total nominal operational expenditure on wheat has climbed substantially, wheat share with other crops (rice, maize, wheat, finger millet, barley, buckwheat, pulses,and oilseeds) and wheat share with the total operational budget has not increased that much. For example, wheat share in crops was 7.92% in 2005 and it fluctuated in between 6 to nearly 10% in the years onwards and reduced to 6.13% in 2016. Similarly, there is a reduction in wheat share with total operational budget as it was 3.1% in 2005 and was reduced to 1.82% in 2016. Since wheat is the third most important commodity of Nepal, the share of the operational budget is lower than supposed to be allocated for the development of wheat research (Table 1).

Table 2 presents CGR of total, crops, wheat operational budget and wheat area, production and productivity from 2005 to 2015. The results showed that the total, crops and wheat operational budget were increasing at the rate of 17.61%, 19.60% and 19.14% per annum, respectively. Wheat area, production, and productivity were also rising at the rate of 1.41, 3.47 and 2.03% per annum, respectively. The pace of increment of productivity and production was higher than the expansion in the area which might be due to the higher rate of adoption of improved wheat varieties and technologies. MoAC (2010) reported that 94% area was covered by modern wheat varieties in the hills and 100% in the terai plains. Timsina et al. (2016) also indicated the variation in coverage of modern wheat varieties ranged from 65% to 95% in hilly districts and from 94% to 100% in different terai districts.

The number of projects on wheat, crops and total from 2005 to 2016 is depicted in Figure 1. The number of wheat project ranged from 10-25 with an average of 16. The No. of crops projects ranged from 156-248 with an average of 192. The total number of projects ranged from 426-633 with an average of 514. In comparison to total projects and crops since 2005 until 2016, the number of wheat research projects seems to be very stable, which indicates the low level of NARC's research priority for the wheat crop. Moreover, comparison of NARC's total budget on research investments in Rice, Maize and Wheat, respectively, during the period from 2005 to 2016 indicates the budgetary allocations on wheat is substantially lower compared to Rice and Maize (Table 1).

Total operational budget, crops operational budget and wheat operational budget allocated by NARC from 2005 to 2016 are shown on Figure 2. The total operational budget has increased substantially from approximately 10.5 million rupees in 2005 to almost 35 million rupees in 2011 and almost 60 million rupees in 2016. Similarly, budget expended for crops research has also shown a similar pattern with total

Table 1. Total, crops, rice, maize and wheat operational budget '000' in NARC (NRs)

Year	Total agricultural budget (Nrs) (A)	Crops budget (Nrs) (B)	Total budget on Rice (Nrs) (C)	Total budget on Maize (Nrs) (D)	Total budget on Wheat (Nrs) (E)	Wheat share in crops budget (E)/(B)*100	Wheat share in total budget (E)/ (A)*100
2005	105089	41162	5480	17074	3261	7.92	3.10
2006	228387	32776	3677	15816	2263	6.90	0.99
2007	111272	39209	4921	15830	3033	7.74	2.73
2008	133507	45898	4871	17848	3868	8.43	2.90
2009	131209	36478	3912	2925	3346	9.17	2.55
2010	122500	34802	3887	3168	2654	7.63	2.17
2011	350000	113992	14651	16926	9802	8.60	2.80
2012	370000	126177	19373	18208	12242	9.70	3.31
2013	294613	113572	16117	15645	8837	7.78	3.00
2014	540300	161814	15031	23023	10667	6.59	1.97
2015	570000	165297	14049	25598	11922	7.21	2.09
2016	587265	174342	12592	22186	10686	6.13	1.82

*1USD = 105.371 NRs in 2016

Table 2. Compound growth rate of total, crops and wheat operational budget, area, production and productivity from 2005 to 2015

Parameters	Total operational budget	Operational budget of crops	Operational budget of wheat	Area	Production	Productivity
Intercept	11.34	10.05	7.53	13.41	14.10	0.69
CGR	17.61**	19.60**	19.14**	1.41**	3.47**	2.03**
R^2	0.70	0.78	0.74	0.82	0.77	0.61

**Significance at 1% level, *Significance at 5% level

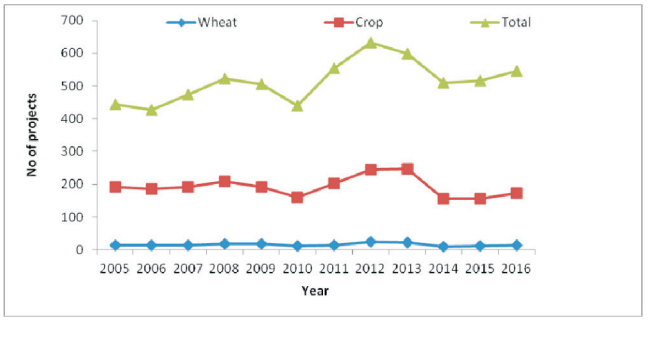

Figure 1. Trend line showing wheat, crop and total number of projects in NARC

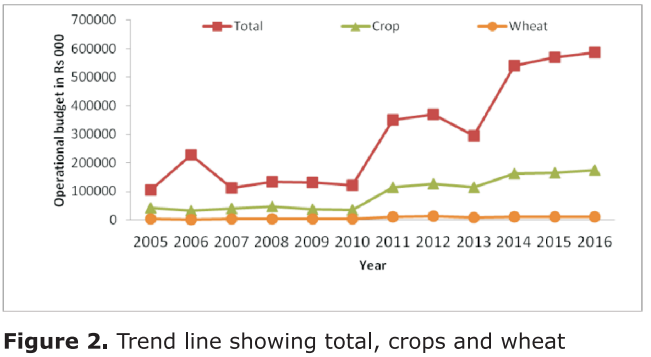

Figure 2. Trend line showing total, crops and wheat operational budget of NARC, Target vs achievements of source seed

budget expenditure. In contrast, the budget growth in wheat research is very low in comparison to crop research budget and total budget, which indicates again the low priority of NARC over the wheat crop research.

Table 3 has compared the target and achievements of wheat breeder seeds and foundation seeds in three intervals (2005, 2010 and 2016). In these intervals, the achievements of wheat breeder seeds were consistently higher than targeted. For 2005, the achievement for breeder seeds was 24.64t, while the target was only 18.7t. Similarly, for the year 2010 and 2016, the achievements were 28t and 41t against the target 24t and 30t, respectively. In the case of foundation seeds, the targets were not achieved in the aforementioned year. Data indicated the supply side of NARC is very strong for breeder seed in comparison to foundation seed. It seems that proactive involvement of private sectors to produce foundation and certified seeds are important to meet the national demands through maintaining proper seed cycle (Timsina et al., 2015; 2018a).

Table 3. Target and achievements of wheat breeder and foundation seed

Year	Target (t)		Achievements (t)	
	Breeder	Foundation	Breeder	Foundation
2005	18.71	105.8	24.64	100
2010	23.6	112.88	27.95	101.63
2016	29.95	172.21	41.037	131.172

Table 4. Average target and achievement of wheat breeder and foundation seed

Year	Target (t)		Achievements (t)	
	Breeder	Foundation	Breeder	Foundation
	17.92	106.13	15.90	112.21
2005-2010	(8.32)	(3.86)	(12.10)	(31.42)
2011-2016	28.73	149.01	34.91	155.69
	(3.25)	(27.99)	(5.64)	(17.08)
	23.32	127.57	25.40	133.95
2005-2016	(8.26)	(29.40)	(13.40)	(33.12)

*Figures in the parentheses indicate standard deviation

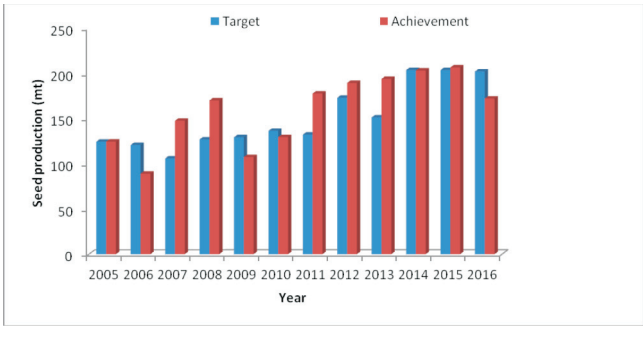

Figure 3. Target and achievement of wheat source seed by NARC in different years

Table 4 presents, the average target and achievement of wheat breeder seeds and foundation seeds. In overall periods, the surplus breeder seeds and foundation seeds produced were higher than targeted. The average breeder seed production in 2011-2016 was higher than the national seed vision projected demand (34.91t) during 2011-2016; however the average foundation seed was much lower than the national seed vision projected demand (582.95t) in 2015 (Table 4). So, the involvement of the private sector such as seed companies, community-based seed production groups would be the viable options for the production of foundation, certified seeds. Timsina et al. (2018a) reported that NARC as a public research agency with expertise in plant breeding should focus only on breeder seed production, while foundation seed should be decentralized to private actors to increase resource use efficiency in the seed cycle. Therefore, close coordination and commitment from the private seed companies, national seed companies, agro-vets and community-based organizations (CBOs) such as community seed groups, cooperatives are required to multiply seeds in subsequent cycles (Timsina et al., 2018b).

The target and achievement of wheat seed production from 2005 to 2016 is shown on Figure 3. In most years, i.e. 8 out of 12 years, NARC wheat seed production crosses the target. NARC was unable to achieve its target in four years which might be due to unfavorable climatic variables. Even though NARC has fulfilled its target by producing surplus seed, private sectors should also be involved in increasing seed production to meet the projected demand of the national seed vision.

After the establishment of NARC in 1991, NARC has released 24 wheat varieties (13 Mexico origin, 1 India origin and 10 Nepal origin) that were under cultivation until 2018 (NWRP, 2018). Among them, 14 wheat varieties were released by NARC in the study period from 2005 to 2016. About 60% released varieties originated from Mexico (CIMMYT). This shows the meaningful contribution of International Agricultural Research Centers on wheat research in Nepal. The yield potential of these varieties ranged from 3.3 to 6.89 t/ha (Table 5), whereas the average national productivity ranged from 2.07 to 2.59 t/ha (MoAC, 2006 to 2011; MoAD, 2012 to 2017). Of the 14 varieties 50% of each were in the hilly and terai domain. The variations in maturity days of the different varieties and domains are also presented in Table 5. In the case of terai, maturity days start from 105 days in Tillatoma variety, whereas it is 156 days in Dhaulagiri, which is recommended for the hills. Despite the number of wheat varieties released and the significant growth in the productivities of the various wheat varieties in the study period, there is still a huge gap between the observed yield potential and the average national productivity. MoAC (2010) has reported that 100% area of plain region of Nepal was covered by modern wheat varieties where 98% varieties were released by NARC (SARPOD, 2017). Due to the open border with India, less than 2% of Indian wheat varieties have been used by farmers whenever there is unavailability of Nepalese varieties in time (SARPOD, 2017). It shows the negligible spillover effect from neighboring countries in wheat production. Gauchan and Dangol (2015) reported top five popular wheat varieties (Gautam, Bhrikuti, Nepal 297, Vijay and WK 1204) in Nepal based on expert elicitation workshop in 2014, which occupy more than 70% of the wheat area in Nepal in 2013/14. Among the top popular five wheat varieties, the origin of only two varieties (Vijay and Gautam) is from Nepal. This shows the significant contribution of the International Agricultural Research Centers on wheat research in Nepal. Only two wheat varieties, namely Vijay and WK 1204, were in that list from the list of released wheat varieties in our study period (Table 5), which hardly occupy 20% of the total wheat area in Nepal. Timsina et al. (2018a) reported that Vijay wheat variety covers about 22% of the share of total wheat seed sold by agro vets in 2015/16. They also established that about 17% of the area is covered by Vijay variety in 2015/16 based on experts panel interview. There is prevalence of older varieties with 12 years of adoption lags and 18 years of weighted varietal age in Nepal (Gautam et al., 2013; Velasco et al., 2013). Promotion of agricultural technologies using community-based organizations and private seed companies is vital to reduce adoption lags (Abebaw et al., 2003; Ainembabazi et al., 2017).

The yield gap between potential and average yield must be minimized by awareness program and make the availability of improved seed with an improved package of practices. Timsina et al. (2016) suggested providing system based packages rather than component technology for mass dissemination and adoption of technology among the farmers at large to increase productivity. Furthermore, the research for bridging the gap between potential and average yield would be a milestone for achieving food security of the country.

Table 5. Released wheat varieties with yield potential, maturity days and recommendation domain

Year of release	Wheat Varieties	Yield Potential (t/ha)	Maturity days	Recommendation domain
2017	Munal	3.3-4.9	160-165	Mid and High Hills
2017	Chyakhura	3.3	160-165	Mid and High Hills
2017	Khajura Duram 1	4.8	125-130	Dang, Banke, Bardiya, Kailali, Kanchanpur districts upto 500 masl
2017	Khajura Duram 2	5.3	125-130	Dang, Banke, Bardiya, Kailali, Kanchanpur districts upto 500 masl
2016	Banaganga	4.9	111-124	Terai and Inner Terai
2016	Sworgadwari	5.5	169-161	Mid Hills
2015	Tilattoma	4.4	105-120	Terai and Inner Terai
2015	Danfe	4.4	163-165	Mid and High Hills
2012	Dhaulagiri	4.5	156	Hills and High Hills
2012	Gaura	4.9	160	Hills and High Hills
2010	Vijay	4.45	111-123	Terai, Tars and Lower Valleys upto 500 masl
2010	Nepal 971	4.5	122	Terai, Tars and Lower Valleys upto 500 masl
2010	Aditya	4.8	118	Terai, Tars and Lower Valleys upto 500 masl
2007	WK 1204	6.89	160-170	Mid and High Hills

*Source: ABD (2017) and Timsina et al. (2018a)

Conclusion

Wheat is the third most important commodity of Nepal. The pace of increment of productivity and production of wheat was higher than the area over the study period. The study shows investment in wheat research has been contributing to increase wheat productivity even though the share of operational budget was lower than supposed to be allocated for the development of wheat research. Moreover, investment on wheat research has generated different proven potential wheat technologies but still needs to harness its potentiality at field level through dissemination of package technology (reduce adoption lags) at the right time on the right location. Moreover, private sectors should also involve proactively to increase current wheat seed production to meet the projected demand of the national seed vision in coordination with NARC and other seed stakeholders. More contribution of wheat research can be expected if more investment in wheat research is allocated. However, it is suggested to carry out further analysis on how much return will be received after investment on wheat research on per unit basis. Moreover, it is suggested to segregate the benefits of national research investments on wheat production and productivity from spillover benefits from neighboring countries and international agricultural research centers in monetary term.

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References

ABD (Agricultural Botany Division), 2017. Annual progress report. Agricultural Botany Division. Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

Abebaw D and Haile MG, 2003. The impact of cooperatives on agricultural technology adoption: empirical evidence from Ethiopia. Food Policy, 38, 82-91.

Ainembabazi JH, van Asten P, Vanlauwe B, Ouma E, Blomme G, Birachi EA, Nguezet PMD, Mignouna DB and Manyong VM, 2017. Improving the speed of adoption of agricultural technologies and farm performance through farmer groups: evidence from the Great Lakes region of Africa. Agricultural Economic, 48, 241-59.

Alston J, Chan-Kang C, Marra M, Pardey P and Wyatt T, 2000. A meta-analysis of rates of return to agricultural R&D, Ex Pede Herculem? Research Report 113, International Food Policy Research Institute, Washington, DC, USA.

Fan S, Fang C and Zhang X, 2001. How agricultural research affects urban poverty in developing countries: The case of China. Environment and Production Technology Division. EPTD Discussion paper No. 83, International Food Policy Research Institute, Washington, DC, USA.

Fan S, Hazell P and Thorat S, 2000. Government spending, agricultural growth and poverty in rural India. American Journal of Agricultural Economics, 82, 1038-1051.

FAO, 2016. FAOSTAT. http://faostat3.fao.org

Fatima H, Badar N and Badar M, 2017. Technical efficiency analysis of agricultural research and development in higher educational institutes of Pakistan. International Journal of Research in Agriculture and Forestry, 4, 16-28.

Gairhe S and Acharya UK, 2017. Fruit research investment in Nepal. In: Proceeding of 9th National horticulture workshop held at National Agricultural Research Institute (NARI), 31st May - 1st June, 2017.
http://doi.org/10.5281/zenodo.1175156

Gairhe S, Upadhyay N and Sapkota S, 2017. Investment in outreach research in Nepal. In: Proceeding of 12th National Outreach Research Workshop held at National Maize Research Program (NMRP), 18-19 June 2017. http://doi.org/10.5281/zenodo.1175189

Gauchan D and Dongol D, 2015. Country report for wheat expert elicitation study, CIMMYT NARC Collaborative Study for Varietal Release and Adoption Data. Strengthening Impact Assessment in CGIAR (SIAC) Project. Nepal Agricultural Research Council (NARC), Kathmandu, Nepal.

Gauchan D and Pandey S, 2011. Is investment in rice research in Nepal adequate and balanced across production environment? Some empirical evidence. Quarterly Journal of International Agriculture, 50, 305-324.

Gautam S, Panta HK, Yelasco ML, Ghimire YN, Gauchan D and Pandey S, 2013. Tracking of improved rice varieties in Nepal. Country report for rice component of the project "Tracking of improved varieties in South Asia". Monograph, International Rice Research Institute, Philippines.

Government of Nepal (GoN), 2013. National seed vision (Seed sector development strategy 2013-2025). Government of Nepal, Ministry of Agricultural Development, National Seed Board, Seed Quality Control Center, Nepal.

Kerr J and Kolavalli S, 1999. Impact of agricultural research on poverty alleviation: Conceptual framework with illustrations from literature. Environment and Production Technology Division Discussion Paper No. 56, International Food Policy Research Institute, Washington, DC, USA.

MoAC, 2005 to 2011. Statistical information on Nepalese agriculture. Ministry of Agriculture and Cooperatives, Government of Nepal, Singh Durbar, Kathmandu, Nepal.

MoAD, 2012-2017. Statistical Information on Nepalese Agriculture. Ministry of Agriculture Development, Singh Durbar, Kathmandu, Nepal.

Morris ML, Dubin HJ and Pokhrel T, 1994. Returns to wheat breeding research in Nepal. Elsevier publication. Agricultural economics, 10, 269-282.

NARC, 2004-2016. Annual Programme and Budget. Planning Division. Nepal Agricultural Research Council, Singhdurbar Plaza.

NSV, 2013. National seed vision 2013-2025. National seed board, seed quality and control centre, Hariharbhawan, Lalitpur.

NWRP (National Wheat Research Program), 2018. Annual report 2017/18. Published by NWRP, Bhairahawa, Rupandehi, Nepal.

Paudyal KP and Khatiwada PP, 2013. Current status of resource allocation for horticultural research under Nepal agricultural research council. In: Proceedings of the 8th National horticulture seminar on horticulture development towards the pace of National economic growth, Khumaltar, Lalitpur and Kirtipur, Kathmandu, 18-20 March 2013, Nepal horticulture society, pp. 83-91.

SARPOD (Socio-economics and Agricultural Research Policy Division), 2017. Annual report 2017/18. Published by SARPOD, Khumaltar, Lalitpur, Nepal.

Shrestha HK and Gairhe S, 2016. Is investment in maize research balanced and justified? An empirical study. Journal of Nepal Agricultural Research Council, 2, 2016. http://dx.doi.org/10.3126/jnarc.v2i0.16118

Thakur NS, Paudel MN, Gauchan D and Shrestha B, 2007. Measuring returns from improved rice, maize and wheat research in Nepal. Nepal Agriculture Research Journal, 8, 103-112.

Timsina KP, Shivakoti GP and Bradford KJ, 2015. Supply situation of vegetable seeds in Nepal: An analysis from policy perspective. Journal of Nepalese Horticulture, Horticulture Society of Nepal, 10, 26-36.

Timsina KP, Gairhe S, Thapa Magar DB, Ghimire YN, Gauchan D and Padhyoti Y, 2016. On farm research is a viable means of technology verification, dissemination and adoption: A case of Wheat research in Nepal. Agronomy Journal of Nepal, 4, 9-24.
http://dx.doi.org/10.3126/ajn.v4i0.15513

Timsina KP, Ghimire YN, Gauchan D, Subedi S and Adhikari SP, 2018a. Lessons for promotion of new agricultural technology: A case of Vijay wheat variety in Nepal. Agriculture and Food Security, 7, 63.
DOI: 10.1186/s40066-018-0215-z

Timsina KP, Ghimire YN, Gauchan D, Sanjel PK, Padhyoti Y and Bista HB, 2018b. Model of agricultural research, extension and education linkages for Nepal's Federal System. Socioeconomics and Agricultural Policy Research Division (SARPOD), Nepal Agricultural Research Council (NARC), publication serial No. 00691-505/2017/18.

Velasco ML, Tsusaka TW and Yamano T, 2013. Tracking of improved varieties in South Asia (TRIVSA). TRIVSA Synthesis Report on Rice, International Rice Research Institute (IRRI). Los Banos, Philippines.