Measuring Returns from Improved Rice, Maize and Wheat Research in Nepal

Naresh S. Thakur*[1], Min N. Paudel[2], Devendra Gauchan[1] and Bhawana Shrestha[3]

[1] Socio-economics and Agricultural Research Policy Division, NARC, Nepal
[2] Outreach Research Division, NARC, Nepal
[3] Monitoring and Evaluation Division, NARC, Nepal

ABSTRACT

Studies on returns to research have been established in different countries to justify research funding and allocation of research priorities. However in Nepal, there are no scientific studies carried out recently on return to research investment in major crops and commodities, despite priority given in agricultural sector. This paper has summarized the research investment with respect to major cereals viz; rice, maize, and wheat and income generated by the impact of improved varieties of these crops in Nepal. Internal rate of return for major cereal crops (rice, maize, and wheat) was estimated using time series data of 1995 to 2005. The findings revealed that there is a negative annual growth rate (-0.59%) of NARC budget during 1998-2004. There was a food deficit during mid nineties, however, in the late nineties while despite tremendous curtailing of budget for research, a surplus of food grain was observed. Although the situation of positive food grain balance is not the result of current year's efforts on research it could be the impacts of years of efforts that were in a continuous pace in the past for agriculture R&D coupled with the impacts of extension related activities in the country. Food surplus is mainly contributed by the efforts of massive release of improved varieties of crops by NARC during late nineties. The internal rate of return (IRR) of these cereals for a decade (1995-2004) was in the range of 84-105%, which is around Rs 235673 millions of income generation while investment for their research was Rs 559 millions (0.24% of their revenue). This indicates that there is gross under funding on research for major crops, despite their significant contribution in national economy, food security, and livelihood improvement in Nepal. Finally paper suggests for increased investment in agricultural research for meeting increasing needs of food, income, and employment of growing population as well as enhancing and sustaining future agricultural R&D in the country.

Key words: Agriculture, food crops, impact, internal rate of return, livelihood, research investment

INTRODUCTION

Agriculture is the largest sector of Nepalese economy, which contributes 39% to the total gross domestic product (GDP) and 65% to the employment of the economically active population (MoAC 2005). Crop coverage is dominated by rice (35%), followed by maize (20%), wheat (16%), cash crops (10%), legumes (7%), minor crops (7%), and horticultural crops (5%). Area coverage by improved seeds of rice, maize and wheat are 74, 69 and 91%, respectively (CBS 2004, MoAC 2005). Likewise, these crops are cultivated in

15,41,729 ha, 8,49,892 ha and 6,75,807 ha with respective productivity of 2.8 t/ha, 2.0 t/ha, and 2.1 t/ha, (MoAC 2005).

Agricultural research potentially helps the poor by augmenting producer's income, reducing food prices to consumers, enhancing the demand for labor, and stimulating growth linkages in the economy (Walker 2000). Agricultural research is an investment for future food production, productivity, and food security. New technologies in agriculture are developed by research while extension takes them to the end users. There have been serious efforts to introduce latest technologies in agriculture research. Technologies are introduced in Nepal by international, regional, and local networks of research activities. In a country like Nepal it is very difficult to conduct basic research and most of technologies are adaptive type and only a few of them are basic ones. In comparison to the countries of South and Southeast Asia the productivity of agriculture in Nepal is very low for cereals (less than 2.8 t/ha).

Agricultural research in Nepal dates back to early 1960s with the establishment of agricultural research stations and commodity research programs in various agroecological zones of the country. These research stations and commodity programs were under same umbrella with agricultural extension despite there were several reorganization of the agricultural departments within the Ministry of Agriculture. Until 1990 the Department of Agriculture (DoA) and the Department of Livestock Services (DoLS) mainly carried out agricultural research under the ministry of Agriculture. In order to focus research on major commodities and enhance the national capability in agricultural research, the Government of Nepal under an Act in 1991 created the Nepal Agricultural Research Council (NARC) an autonomous institution with a national mandate for agriculture research in Nepal.

NARC's attention is focused on improving access and uptake of complete package of improved technologies in farmers' level that is directed by Agriculture Perspective Plan (1995), National Periodic Plans and NARC Vision (2002). These have laid emphasis to poverty reduction by increasing agricultural productivity and farm income through adoption of improved technologies. To address APP priorities, Government of Nepal has allocated a sizable amount of resources to improve food security as well as the living standards of the rural masses. Major source of resources for agricultural gross domestic product (AGDP) in Nepal comes from APP priority commodities especially cereals such as rice, maize and, wheat, which are the three prime staples in the country. NARC has also given a high priority for research in these crops. However, investment in research in Nepal is very low as compared to its contribution in national economy. Available data show that investment in agriculture research in many part of the world is around from 0.5 to 2% of AGDP while in Nepal it is less than 0.2%.

Studies on returns to crops have been established in different countries. Echevrria (1990) has done work on return to investment on wheat in different countries and documented the internal rate of returns as 90% (Mexico), 30-35% (Bangladesh), 97% (USA), 30-39% (Canada), 58% (Pakistan), 18-36% (Peru), and 110% (Brazil). Similarly Mruthyunjaya et al (2004) estimated IRR of 24-67% for cultivation practices of rice with other crops on rainfed technology in India. In Nepal, return to investment was estimated with IRR of 74% for wheat research and about 84% for wheat breeding during seventies to nineties (Morris et al 1994). They also projected IRR of 49% for future wheat breeding in Nepal. A few studies conducted in Nepal have indicated that the investment on the crops research is worth paying because of a very positive internal rate of return as considerable farm families have been benefited from these crop technologies (Hocking et al 1995). However, recently (after 1990s) there are no scientific studies dealing with impact of research investment in major crops such as rice, wheat and maize in aggregate to justify future research resource allocation and funding priorities in Nepal. Considering the importance of research investment and justification for future allocation of research resources in major crops, it has therefore become imperative to know how much budget is allocated for agriculture research and what the internal rate of return is for the investment as a whole for these major as well.

The prime objective of the study is to provide information for major food crops (rice, maize, and wheat) with respect to economic parameters, which could provide justification of expenditure incurred on these crops in Nepal. However, the specific objectives are to provide scientific information about economic tools that could help provide planners and decision makers to allocate appropriate funds for attaining fruitful return from research and development (R&D) of these crops in days to come.

MATERIALS AND METHODS

This paper tries to gather information for major food crops with respect to actual expenditure on research that could explain what percentage of internal rate of return (IRR) and growth rate (g) are achieved by the expenditure incurred on them. Ultimately findings could be used as tools for convincing policy makers, donors, research managers, and related authorities in order to decide an appropriate amount of funds allocated for NARC to conduct meaningful research for these crops as well as setting future priorities in agriculture R&D. This will also help justify research work of NARC effectively in future because there is a dearth of resources in NARC as compared to its contributions for the country as a whole. Since NARC technologies are being disseminated and their adoption have been picking up in the farmer's field, the economic impacts are visible from various sources. In today's world of scarce public funding and greater accountability, governments, donors and research managers are increasingly demanding assessment of the economic returns to their investments in research (Maredia et al 2000).

Rice, maize, and wheat crops are selected purposively to calculate economics parameters of IRR, from time series data of 1995 - 2005. Actual expenditure incurred for these crops was taken from the expenditure of respective national research programs, percentage of actual expenditure in Agronomy (rice 70%, wheat 20%) and Botany (rice 40%, wheat 30%, and maize 20%) Divisions, Khumaltar, and cost of cultivation based on the average cost of cultivations reported by the Economic Analysis Division of Department of Agriculture for the districts situated for commodity programs of these crops. Percentage of area covered by improved varieties of these crops was recorded from the time series data of statistical survey of Agriculture of the Ministry of Agriculture and Cooperative (MoAC 2005). Production of improved varieties for these crops was estimated with respect to their respective percentage of areas covered by improved varieties times productivity of improved variety. In the areas grown for improved varieties, a projection of production for local variety was estimated by multiplying productivity of local variety. The actual production for improved varieties was the difference between the productions of improved varieties less projected productions of local varieties in the areas grown for improved varieties. The analytical tools for financial analysis for IRR and annual growth rate (Gittinger 1972) were estimated from the difference of production between improved varieties and projected production of local varieties obtained from the areas grown for improved varieties. This production difference was again estimated based on the current market price of the respective crops that gave total production in prevailing market price. A period of ten years (1995-2005) is considered for economic analysis. Market prices are used for computing the value of production because price and transportation subsidies on inputs have been removed by the government of Nepal. A discounting factor is used for estimating the present value of costs and returns to be used for calculating NPV.

There are several options for evaluating the stream IRR and annual growth rate (G). The best approach is to use a combination of IRR and G calculations to summarize the relevant information on the total returns to research. These economic parameters are and the standard procedures are outlined below:

Where,

a) The IRR is defined as the rate of an investment which we equate the present value of benefits and costs. It is found by an iterative process and is equivalent to the discount rate (r) that satisfies the following relationship:

$$\sum\left[(Bt - Ct)/(1 + IRR)t\right] = 0$$

Where, IRR represents the internal rate of return, B benefits from the crop commodity programs, and C actual expenditure of the crop commodity programs plus cost of cultivation of crop in question.

Bt = Benefit in year t

Ct = Research costs in year t
t = year goes from 0 to n< ∞
b) The annual growth rate;

$$G = \left[\left(\frac{vt}{v0} \right)^{1/t} - 1 \right] \times 100$$

Where; G be the growth rate; vt = Value in time t, and v0 = Starting value in (time = 0),
This ration compares the discounted benefits to discounted costs.

RESULTS AND DISCUSSION

Area and production

Analysis of the data revealed that the total area of rice, maize, and wheat has increased by 12.7%, 10.2%, and 8.1%, respectively in 2005 as compared to 1995. It could be due to expansion of net areas, which brought new land into cultivation and consequently increased in cropping intensity. The most significant change has been observed in 2004 (15,59,436 ha) in areas planted to rice. The area increases to maize and wheat were not substantial like that of rice in the same period. Similarly, increased productivity of rice, maize, and wheat is estimated by 30.9%, 19.6%, and 41.1%, respectively in the 2005 as compared to 1995 (Table 1). The rate of change in wheat productivity is highly significant over the period of 10 years because of many improved technologies adopted by farmers. The increase in cereal crop productivity is mainly due to improved quality seeds and complete package of practices of technologies generated and developed by respective commodity research programs. However, the component of increase into area and yield indicates that the area expansion play a significant role to enhance the productivity in cereals because of widespread prevalence of local production practices. Significance increases in agricultural production, however, are possible with the development, production and distribution of new variety seeds and improved technologies.

Table 1. Trend in cereal grains production for 1995 and 2005

Crop	Total cultivated area, ha			Productivity of improved variety, t/ha		
	1995	2005	% Change	1995	2005	% Change
Rice	1368423	1541729	12.7	2.623	3.037	15.8
Maize	771410	849892	10.2	1.881	2.009	6.8
Wheat	624329	675807	6.4	1.598	2.134	33.5

Source: MoAC 2005.

There is a high potential for spreading improved varieties of major cereals because of R&D activities, which has been developing full package of technology through NARC, extension and I/NGOs in farmer's level. Total released varieties of rice, maize and wheat are 49, 17 and 28 respectively during the study period 1995-2004. Farmers had increased options for choosing and selecting seeds of improved varieties after the inception of NARC as per their local socioeconomic needs and to fit in their cropping systems in a given recommended domain. Productivity change brought about by improved varieties ranged from 15-33%, which is very encouraging as compared to other countries in Asia. Pandey and Rajatatsereekul (1999) reported that in Thailand increase in rice yield from improved varieties over currently grown varieties was 10%. This could be because of wide spread cultivation of improved varieties in Thailand compared to few improved varieties grown in Nepal. The use of improved seeds in Nepal is gradually increasing for wheat, rice and maize (Table 2). Wheat has maximum coverage of improved varieties followed by maize and rice indicating the respective comparative advantage of these crops with respect to generation and adoption of these varieties in farmers' fields. Data indicate that only limited percent of farmers still continue to grow indigenous varieties from their own sources in these crops.

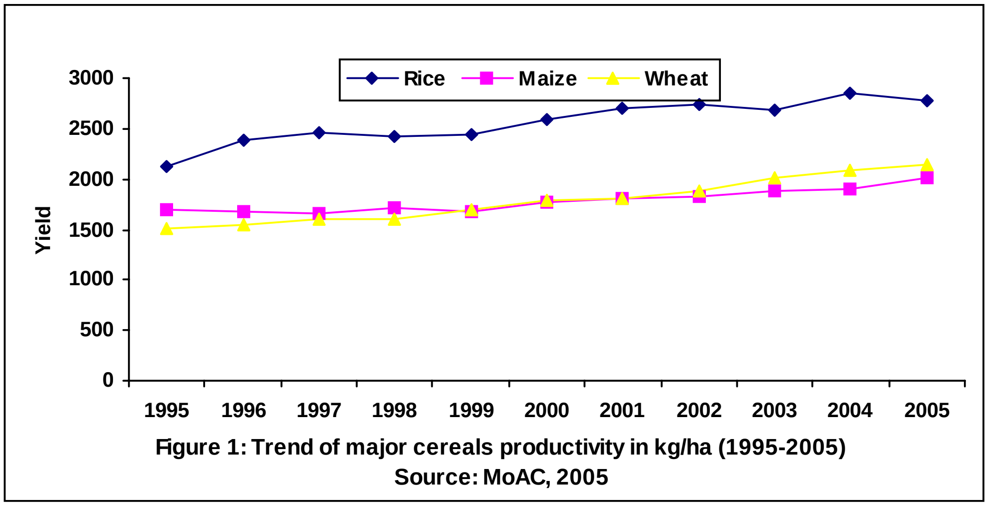

Figure 1. Trend of rice, maize and wheat productivity from 1995 to 2005.

TABLE 2. AREA COVERED BY HYVS OF MAJOR STAPLES IN 1995 AND 2004

Crop/year	Total area coverage, ha		Area under HYVs, ha		% Area under HYVs	
	1995	2004	1995	2004	1995	2004
Rice	1369423	1559436	767014	1291837	56.01	82.84
Maize	771410	834285	448035	709309	58.08	85.02
Wheat	624329	664589	527808	633951	84.51	95.39

Source: MoAC 2005.

For these crops the income generation from improved varieties is extensively higher than that of local. However, there is a remarkable contribution of local varieties to generate income as well. The maximum contribution of improved varieties coverage for these crops is about 80-95% (Table 2) and there is a corresponding contribution of income generation by them. Income generated by the impact of improved varieties of these crops from 1997/98 to 2004/05 was estimated Rs 235673.54 millions while investment for their research was only of 0.0025% of their revenue (Paudel et al 2006). At present, budget allocation for full phase research in NARC is not up to the extent what it should be. However, the impact of research in cereals has been clearly visualized by positive change in income in current year as compared to 1995, which was before inception of NARC. For a meaningful contribution of these crops to the national AGDP, the budget allocation for research should be allocated at par with developing countries where 0.56 percentage of AGDP was put for research in 51 developing countries around 20 years ago (Thapa 1996). In present context, budget allocation to research in neighboring countries including India has increased more than 0.5 percent of AGDP while in Nepal this is hovering around 0.016 percent of AGDP (MoAC 2005, ITAD/New Era, 2005). This clearly showed that agriculture research in Nepal is grossly under funded.

To cite an analogy of expenditure on research, income obtained from improved varieties, proportion of research expenditure to income obtained, and IRR for major cereal crops has been illustrated (Table 3). Research cost for rice, maize, and wheat plus cost of cultivation for districts where these crops commodity programs are situated is considered as the actual cost of research spent by national crop commodity programs of these crops plus actual expenditure incurred for Agronomy and Botany Division, Khumaltar during the period. So far as research investment with respect to income obtained from improved varieties is concerned it is the difference between the productions obtained from the areas grown for improved varieties less projected production of local varieties from the areas grown for improved varieties. Therefore, the percentage of proportion with respect to research investment is the income solely obtained from the income of improved varieties of cereals that have covered certain percentage of total areas.

A comparison of trend in major cereals production with respect to area cultivated and productivity of improved variety in 1995 and 2005 has shown that both the area and productivity of major cereals have been increased (Table 1). The increase in productivity for maize is found less than increase in cultivated areas during ten years while increase in productivity for rice and wheat is significantly more than that of areas for the same period. This suggests that there has been remarkable impact of technologies to yield a positive effect on productivity for rice and wheat compared to maize in which increase in production was associated with increase in cultivated area. This may be because of the condition that maize is comparatively grown in less fertile land than that of rice and wheat, which are grown in more fertile land. At the same time maize is a crop of poor man who lives in hills where the impact of new technologies are less effective compared to rice and wheat.

Table 3. A comparison of expenditure, return, and internal rate of return from 1995 to 2004

Crop	Research expenditure (million Rs)	Income obtained from improved variety (million Rs)	Proportion of research investment with respect to income obtained from improved variety, %	Internal rate of return (IRR), %
Rice	167.12	151036.64	0.1106	105.00
Maize	182.89	38299.17	0.4775	84.04
Wheat	209.54	46337.73	0.4522	103.02
Total	559.55	235673.54	-	-

Source: ITD/New Era 2005.

Our concern is that out of millions of income generated by the impact of new technologies at least 1%, which is equivalent to Rs 2356.7 million at present value, should be invested for research (Table 3). But research investment as of now for these crops is 0.24% of the income obtained from improved variety. Although there are numerous commodities for which new technologies have been generated by agriculture research only the most important cereals is shown for an example. Because these commodities cover around 99% of the total cultivated areas in Nepal. The IRR of cereals for a decade is in the range of 84-105%, which is a very encouraging for investment, where agriculture is the predominant sector for employment generation and GDP contribution.

New technologies primarily come through NARC however, some of the farmers bordering to neighboring countries get improved technologies. The number of released varieties of rice, maize, and wheat are 8, 5 and 6, respectively during 1995-2004 (Table 4). Farmers groups in different locations also produce HYVs in participatory approach in their fields for seed multiplication. Productivity of improved varieties is far more than the national productivity of these crops. This potentiality of productivity could be enhanced by effective dissemination of such technologies in farmer's field in wider scale.

Table 4. Improved varieties of rice, maize and wheat released during 1995-2004

Variety	Released year	Productivity, t/ha	Recommendation domain
I. Rice			
a. Early			
1. Hardinath-1	2004	5.0	Tarai, inner Tarai, valley and river basin areas
b. Main season			
1. Chandannath-1	2002	6.0	Jumla valley and similar high hills (2300 m)
2. Chandannath-3	2002	6.0	Jumla valley and similar high hills (2300 m)
3. Khumal-11	2002	10.0	Kathmandu valley and similar areas
4. Manjushree-2	2002	8.3	Kathmandu valley and similar areas
5. Rampur Masuli	1999	5.7	Tarai, inner Tarai, foothills in Central and Western development regions (> 900 m)
6. Khumal-6	1999	7.8	Kathmandu valley and similar areas
7. Machhapuchhre-3	1996	5.0	Mid to high hills for cold climates
II. Maize			
1. Gaurav Hybrid	2003	9.0	Tarai, inner Tarai and foothills (summer and winter)
2. Manakamana-3	2002	10.6	Mid-hills of Eastern, Central and Western regions
3. Ganesh-1	1997	5.0	High hills
4. Rampur-1	1995	3.8	Tarai, inner Tarai
5. Arun-1	1995	4.0	Tarai, inner Tarai
III. Wheat			
1. Gautam	2004	5.0	Timely and late sown irrigated condition of Tarai, Taars and lower valleys

Variety	Released year	Productivity, t/ha	Recommendation domain
2. BL-1473	1999	4.0	Irrigated medium to high fertility condition of whole Tarai, Taar and low altitude
3. Kanti	1997	5.5	All hill areas
4. Pasanglhamu	1997	6.7	Mid-hills (Kathmandu, Jumla)
5. Rohini	1997	4.1	Tarai, Taar and < 1000 m
6. Achyut	1997	4.5	Tarai, Taar and < 1000 m

Research expenditure

The study revealed that the proportion of research investment for NARC in comparison with national and MoAC budget has declined and reached climax in 2002. It is important to note that the share of NARC to the national and MoAC budget has increased after 2002 and reached up to the level of 0.58% and 14.71%, respectively. National and MoAC budget have increased in a small pace for seven years (1998-2005) but there is a negative allocation of budget for NARC during the same period. The annual growth rate of budget for NARC is estimated to be -0.59% whereas national and MoAC budget is 7.63% and 2.17%, respectively from 1998 to 2005 (Tables 5). However, APP has set a target of doubling agricultural research budget from the current year level of Rs 180 million to Rs 360 million per year for the next 20 years (APP 1995). Low budget allocation for NARC indicates less priority for research in the country. Such a negative trend of budget for research can result into low productivity in the long run, which should not be the case of agro-based country like Nepal. There has been significantly decrease of donor support for NARC due to political instability, resource crunch and insurgency in the recent years in the country.

Table 5. Comparison of NARC budget with national and MoAC budget ('000 NRs)

Year	National budget	MoAC budget	NARC budget	Proportion of NARC budget to national budget, %	Proportion of NARC budget to MoAC budget, %
1995	-	-	205382	-	-
1996	21904189	2388779	195412	0.89	8.18
1997	-	-	207393	-	-
1998*	62022294	2267193	326422	0.53	14.40
1999*	69693337	2350968	315706	0.45	13.43
2000*	77238226	2857489	322597	0.48	13.04
2001*	91621335	3360573	486586	0.53	14.48
2002*	99792219	3927556	577760	0.58	14.71
2003*	96124796	2423526	297780	0.31	12.29
2004*	102400000	2472945	300575	0.29	12.15
2005*	111689900	2692284	311249	0.28	11.56
Growth rate %	7.63	2.17	(-) 0.59		

*Source: * ITAD/New Era 2005.*

A ten year's edible grain production and requirement balance sheet of Nepal has indicated that from the year 1994/95 to 1998/99, there was a food deficit while from the year 1999/00 to 2003/04 there is a food surplus (Table 6). This shows that the impact of research in Nepal has shown its effect on food grain production with a positive food balance in the recent years. Despite a tremendous curtailing of budget for research, the growth rate of a budget for NARC being negative (-.059%) while it is positive for national budget (7.63%) and budget of MoAC (2.17%) for the same period, NARC is still giving vital technologies to agriculture in Nepal. The positive impact of research can not be visualized in few years' efforts rather it is the impact of years' that were in a continuous pace in the past. At the same time agriculture in Nepal is dependent on monsoon because of massive rainfed nature farming in the country. Because the final outcome of research are only visible during a long period of time, may be tens of years of investment on research could only be visible. Therefore, here comes the importance of continuous efforts on agriculture R&D, which has a pivotal role for maintaining food sustainability in a country whose economy is dependent on agriculture.

Table 6. Edible cereal grain production and requirement of Nepal (1995-2004)

Fiscal year	Total production, ton	Total requirement, ton	Total balance, ton
1994/95	3397760	3882915	(-) 485155
1995/96	3913878	3948229	(-) 34351
1996/97	3972587	4079135	(-) 106548
1997/98	4027349	4178077	(-) 150728
1998/99	4097612	4279491	(-) 181879
1999/00	4451939	4383443	68496
2000/01	4513179	4430128	83051
2001/02	4543049	4463027	80022
2002/03	4641466	4565820	75646
2003/04	4835973	4683272	152701

[a] Source: Ministry of Agriculture and Cooperatives 2005.

The data presented in this study show that agricultural research that will benefit small farmers through the availability of daily staples, nutrition, low food prices and income in a poor developing country like Nepal is severely under funded. Social rates of return to most past investments in agricultural research have exceeded 20 percent a year. For developing-country governments this is a most worthwhile investment. Yet low-income developing countries invest less than 0.5 percent of the value of farm production in agricultural research, compared with 2–5% in higher-income countries. Since research is typically a public good, it needs to be financed to a large extent by the government. In view of declining donor support for agriculture research, NARC needs to be proactive for looking funds through various sources including private sectors, I/NGOS, bilateral donors, international organizations, etc. The changing socio-economic and institutional context of R&D, the changing nature of clients, partners and funding sources are to be understood by the NARC to make its research system effective, responsive and dynamic in partnerships with multiple stakeholders (Gauchan et al 2003). There is an urgent need to improve efficiency, management, and the incentive in research in order to maximize benefits from limited government budget provision to research. This is essential not only for improving the performance of agricultural sector but also to have a sustainable funding source.

Estimating the actual return to investment in agricultural research is complicated by the dispersed area over which research impacts may occur and the large number of external factors in addition to research induced technical changes affecting production, productivity, income and employment etc. Estimated rates of return to research are distorted by problems of attributing the credit for particular research-induced productivity increases, among research expenditures undertaken at different times, in different places, and by different agencies (Alston et al 1998).

In addition, since separate aggregated data on improved varieties were not available, the data used for estimating returns here are mainly of general time series data on production and productivity where improved variety data were imputed from area on overall crop varieties. Similarly the increased production and productivity of crops are combined effect of research and extension interventions, where here only research costs particularly of major commodity programs and two of the disciplinary divisions are included. Moreover, the study is primarily based on secondary information without using primary field survey data on adoption of improved technologies, costs, market price, yield, elasticity and other data from experimental trials. This study also does not take into account of effects of other policy and programs for which dynamic analytical methods such as economic surplus measures and econometrics technique could be used.

Agricultural research generates several indirect economic effects, including labor-market effects and growth linkages of technical change, that go beyond the cost-benefit analysis using IRR, NPV, BCR and use of standard measures of consumer and producer surpluses. The effect of technology adoption on demand for labor has potentially major indirect benefits. Overall effects of technical change as a result of research ultimately depend on general growth and income effects induced throughout the economy by consumption, input and output linkages. A full accounting of these effects requires a general equilibrium (GE) model (Maredia et al 2000). In the future rigorous analytical methods combining technical, scientific, and economic information from a number of sources could be taken into consideration while estimating rate of return on agricultural research.

CONCLUSION

The area and productivity have been positively increasing during 1995-2005 due to improved quality seeds and complete package of practices generated and developed by NARC research programs. Productivity of cereals has brought to change by improved varieties from 15 to 22%, which is very encouraging as compared to other countries in Asia. Income generated by the impact of improved varieties of major cereals during 1998-2005 was estimated Rs 235673.54 million but investment for the research was only 0.0025% of their income. The total budget allocation for NARC is hovering around 0.016% of AGDP. This clearly indicates that agricultural research in Nepal is grossly under funded. For agriculture research there should be at least 1% of the total income generated by the impact of new technologies at present value. But now, research investment for these crops is 0.24% of the income obtained form improved varieties during a decade. The estimate of IRR of major cereals is in the range of 84-105%, which is a very encoring for investment where agriculture is the main livelihood sector of masses especially the poor. During a decade (1995-2004) the budget growth rate for Government of Nepal (7.62%), MoAC (2.17%) is positive while for NARC it is negative (-.0.59%). The low budget allocation for NARC indicates less priority for research investment in the country. Such a negative growth rate of budget allocation for research can result into low productivity in the long run, which should not be the case of agro-based country like Nepal.

There is an urgent need to significantly increase NARC budget allocation for research in order to generate new technologies with active participation of farmers aimed at increasing agricultural production and productivity. Government of Nepal should provide budget allocation aimed at achieving the minimum target of investing at least 1% of the AGDP in agricultural research in periodic five-year plans from now onwards. In current situation, government of Nepal should also declare strong commitment to agricultural research by substantially increasing budget allocation in order to attract increasing donor assistance. Price and transportation subsidies on inputs were removed in Nepal as part of the fiscal burden by the government. Fund saved through this measure can be used for NARC research through farmers' participation in research. In view of declining donor support for agriculture research, there should be functional linkage among public private and partnership principles of concerned stakeholders.

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