Benefit-cost analysis of participatory breeding program in Syria

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Abstract

Participatory plant breeding is seen by several scientists as a way to overcome the limitations of conventional breeding by offering farmers the possibility of deciding which varieties better suit their needs and conditions without exposing them to any risk. It exploits the potential gains of breeding for specific adaptation through the selection in the marginal environment. The participation of farmers increases the probability and speed of adoption as well as the breeding efficiency and the effectiveness of the breeding program.

The objective of this study is to estimate and compare the benefits and costs of participatory and conventional barley breeding programs. Benefit-cost analysis was used to analyze the costs and benefits of the PPB program at ICARDA and the conventional program at ICARDA and NARS.

To assess the benefit-cost analysis for breeding programs, data were collected form ICARDA projects in barley breeding program, farm survey, and national agricultural research program in Syria. These data included costs of different activities in participatory and conventional breeding programs in ICARDA, and the national program, human capital in barley breeding, total area planted with barley, percentage of area planted with new varieties of barley, yield advantage of improved variety, and barley price,

Gross economic benefit GEB model was used to calculate the benefits associated with the two programs. Costs were calculated for both PPB and conventional programs. And they included personnel costs, overhead costs, operational costs, workshops and training costs. The cost that farmers have to pay during his participation in the PPB and the benefit they gain from adopting the varieties selected by this program were estimated.

The results show that the gross economic benefit achieved by conventional research is 31 million dollar, while the participatory research contribution is for one year only and is equal to 1.6 million dollar. The present value of participatory benefit is 1.6 million dollars. The present value of the conventional benefit for the whole period is 30 million dollars .

The comparison of the total costs of the two programs shows that there is no significant difference between the PPB costs and the CPB costs. However, the present value of conventional cost is higher than that of participatory costs. Since the distribution of them over time is different.

The benefit cost ratio was calculated after having the PV for benefits and costs of the two breeding approach. Results show that B-C ratio for conventional program is 68 and this is far away from 1, For participatory, B-C ratio for one year only is 2.5. This

indicates that, the benefits generated by these programs are much more than the money invested in them.

Introduction

Barley is mainly grown under harsh environments with low rainfall and it is mainly cultivated by small resource-poor farmers in areas where no other crop could grow, thus barley improvement research should benefit those small resource-poor farmers the most. It is widely recognized that conventional barley breeding has been more beneficial to farmers who could profitably modify their production practices to suit new cultivars, than to farmers who could not afford to modify their production practices through the application of additional inputs and could not risk the replacement of their traditional, well known and reliable varieties. Participatory plant breeding (PPB) overcome the limitations of conventional breeding by offering farmers the possibility to decide which varieties suit better their needs and conditions without posing risks to livelihoods. It exploits the potential gains of breeding for specific adaptation through the selection in the marginal environment. The participation of farmers in the very early stages of selection offers a solution to the problem of fitting the crop to a multitude of both target environment and users' preferences (Ceccarelli et al., 2001). Meanwhile, farmers' participation increases the probability and speed of adoption as well as the breeding efficiency and the effectiveness of the breeding program (Ceccarelli & Grando, 2002). The International Center for Agricultural Research in the Dry Areas (ICARDA) has begun in 1991 to gradually decentralize most of the selection work in barley to national programs. This has been followed more recently by a number of participatory barley breeding programs in Syria, Egypt, Jordan, Tunisia, Morocco, Yemen, and Eritrea. One limitation of the current participatory plant breeding (PPB) work is that most of the institutions promoting farmers participation are not those responsible for plant breeding. And this lead to limit the scale at which PPB has been adapted by the national program and limited its large-scale impact. It is also believed that PPB methods have higher cost to both Institutions and farmers than conventional breeding. Therefore, the issue of a possible additional cost is often the main reason why Institutions are reluctant to embark in the PPB programs (Mangione et al., 2005). A research institution will incur net additional costs by adopting PPB. These will be costs associated with additional travel, agricultural chemicals, possible land leasing, additional vehicles, and additional labor, etc (Zeigler, 1996). Others stated that operation costs of participatory breeding are higher than that of conventional breeding (Lilja and Aw-Hassan, 2002). However, some researchers stated that participatory work reduces costs of the public sector (Pachico, 1996). Since, traditional on-farm research requires an enormous amount of monitoring by scientists and technicians, efficient participatory research can replace much station research, thereby reducing costs through cost sharing, although the farmers contribute through their efforts rather than financially. And farmers' participation in selection reduces costs of land rent and labor (Sthapit et al., 1996). Finally, we cannot conclude that participatory breeding causes a major increase in the cost (Ashby and Lilja, 2004). Participatory barley breeding was conducted in Syria on the base of two principles:

1. The trials are grown in farmers' fields using farmer's agronomic practices.

2. Selection is conducted by farmers in farmers' fields, so that farmers are the key decision makers.

Estimating the cost of a program is not enough to know how good the economic situation of that program is. The costs should be compared with the benefits associated with it. The ratio of the two components, benefit-cost ratio, shouldn't be less than one otherwise the project will be losing.

The objective of this study is to estimate the costs and benefits of conventional and participatory plant breeding programs and to conduct a benefit-cost analysis for them.

Material and methods

To assess the benefit-cost analysis for conventional and participatory plant breeding programs, data were collected form ICARDA projects in barley breeding program, farm survey, and national agricultural research program in Syria. These data included costs of different activities in participatory and conventional breeding programs in ICARDA, and the national program, human capital in barley breeding, total area planted with barley, percentage of area planted with new varieties of barley, yield advantage of improved variety, and barley price,

In this study conventional plant breeding is defined as the type of breeding where all selection and part of the yield testing take place in research stations, while, final stages of yield testing take place in farmer fields. On the other hand, participatory plant breeding is defined as the type of breeding in which the selection and the yield testing are conducted jointly by breeders and farmers in farmers' fields. At each cycle the opinion of the farmers determines which material is promoted to the next cycle (Mangione et al., 2005). Except for planting, breeders managed the experiments on research station, while the farmers managed those in farmers' fields.

Three types of farmers were interviewed in the farm survey conducted in 2004-2005 season; host farmer is the farmer who host one or more trials in his field; evaluator farmer is one of the neighboring farmers who participate in the selection; and non-participant farmer. Each host farmer made the selection in his field and in the research stations. The professional breeders selected in each farmer's field and in the research stations. Evaluators, group of neighboring farmers, also made selection.

The farm survey conducted in five provinces in Syria, Aleppo, Edlib, Hama, Hassaka, Raqqa, Daraa and Swaida. These are the areas of barley production, and where the participatory barley breeding program took place. The survey was conducted of 198 farmers, 66 farmers of each group specified above.

Data of expenditure of the national agricultural research program on conventional research is still in the collection process. And this made this part of the analysis covers only ICARDA' work in plant breeding.

Barley production in Syria

Barley is an important crop in Syria; it is the principal feed crop for sheep, which are area major enterprise for farming communities in marginal areas. Barley planted area is over 2 million hectares with little use of improved varieties. It covers a wide range of barley growing environments with average annual precipitation range between 200 and 350 mm. At wet area and fertile soil, favorable environment, farmers can obtain up to 5 t ha^{-1} of barley grain in a good season and use of fertilizer. At the driest part, soils are generally poor, input levels are low, and grain yields vary from nothing to 1.5 t ha^{-1}. National average barley grain yields are low at 0.65 t ha^{-1} (Ceccarelli et al., 2001). Most of the barley is grown in a low input risky environment, marginal environment, with barley as the common rainfed crop with limited choice of alternative crops and cropping systems.

Thœxperiments locations represent a range of climatic conditions from wet to dry. Participating farmers are representing different levels of literacy (illiterate to college scholar), of farm sizes (from 1ha. To 200 ha.), of family size (from 1 person to 35 people), of income, differences in the importance of barley in the production system, and different types of farming systems with respect to the interaction between crops and livestock production.

Plant breeding programs

The method of plant breeding used in Syria is a bulk-pedigree, in which the crosses are prepared on station, where the F_1 and the F_2 are grown. Then, three years of yield testing and selection of the bulk breeding material take place (fig.1). The yield testing begin with unselected F_3 bulks in trials called Barley initial trials (BIT) in the conventional program and Farmer Initial Trials (FIT) in the participatory program. The field testing of the selected F_4 bulks takes place in trials called Barley Preliminary Trials (BPT) in the conventional and Farmer Advanced Trials (FAT) in the participatory program. This will be followed by the field testing of the selected F_5 bulks in trials called Barley Advanced Trials (BAT) and Farmers Elite Trials (FET) in the two programs, respectively.

BIT, BPT, and BAT are grown only on research stations while FIT, FAT, and FET are grown in farmers' fields. The activities in farmers' fields begin with the FIT, which are unreplicated trials with 200 plots of $12m^2$: these contain 170 entries plus one or two checks repeated 30 times. The breeding material selected from the FIT are tested for second year in the FAT with a number of entries and checks that very from village to village and from year to year. The plot size in the FAT is $45m^2$ to produce enough seed on farm to plant the selected entries on larger plots size in the third stage. The entries selected from the FAT are tested in the FET, with a plot size twice as large as the FAT (Ceccarelli and Grando, 2004). Seed multiplication is conducted on station for both types of breeding programs. In the case of conventional program, the best lines from the BAT are included in a three-year program of yield testing called On-Farm Trials (OFT). These

are conducted in cooperation with the staff of the National Program. In the case of the participatory program, FIT, FAT, and FET generate the equivalent set of data of the OFT. Therefore, one of the largest differences between the two types of breeding programs is the time required to reach an equivalent stage of breeding in relation to variety release (six years for participatory program and nine years for the conventional program). By implementing the participatory plant breeding program instead of conventional program, part of the breeding materials that are usually grown on station are transferred to farmers' fields, and part of the decisions that are usually taken by the breeders transferred to farmers.

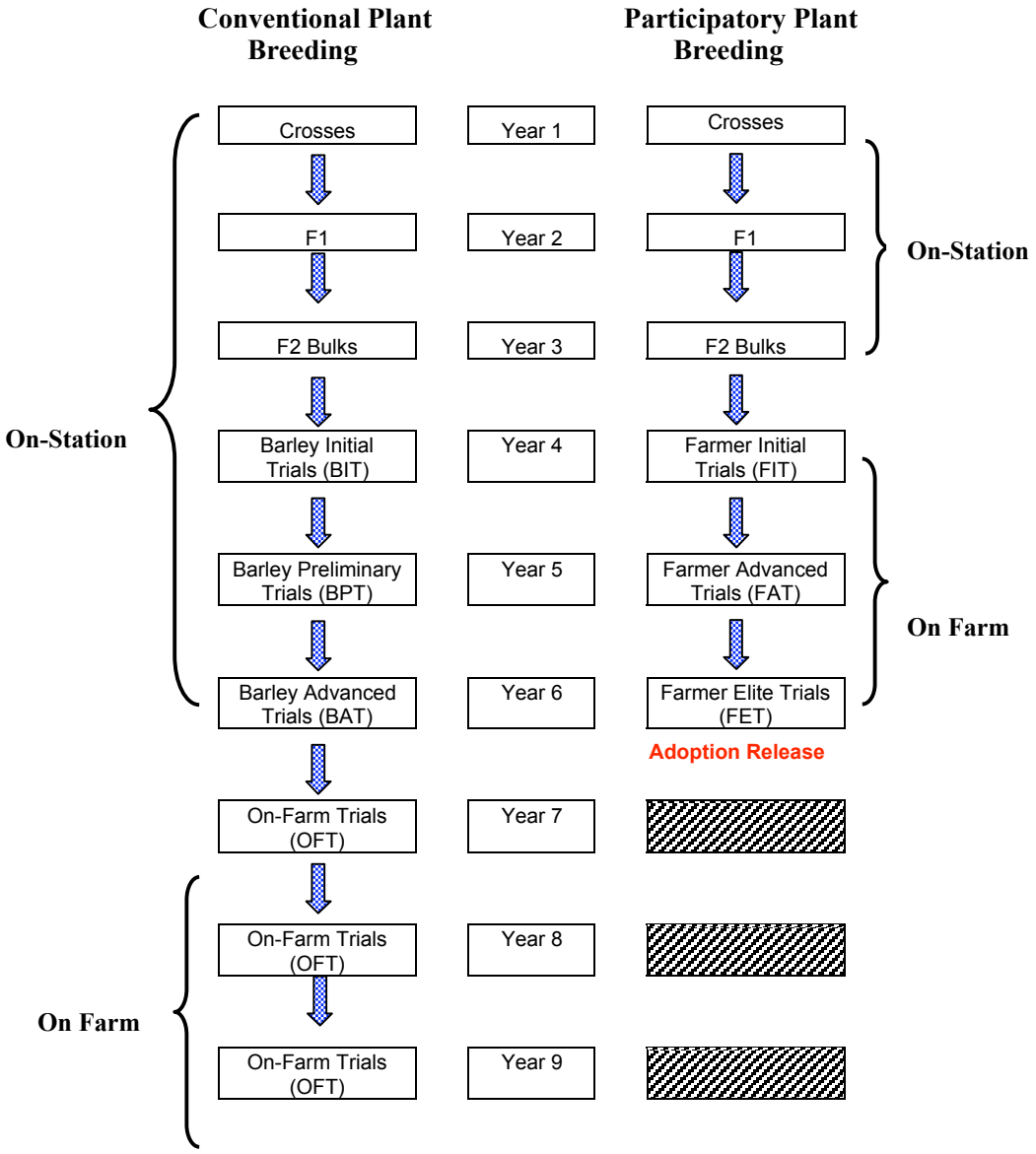

Fig 1. The two plant breeding programs implemented in Syria.

One of The most important advantages of PPB is associated with reversing the delivery phase of a plant breeding program. The most promising lines in the conventional program are released as varieties, their seed is produced under controlled conditions (certified seed) and only then do farmers decide whether or not to adopt them. In many developing countries this process results in many varieties being released and only a small fraction are being adopted. In this case, the considerable investment made in developing this variety and in producing its seed has no benefit. With PPB it is the initial farmers' adoption, which drives the decision of which variety to release. As a consequence, adoption rates are expected to be higher, and risk is minimized, as intimate knowledge of varietal performance is gained as part of the selection process. Last but not least, the institutional investment in seed production is nearly always paid off by farmers' adoption.

Methodology

The two most common economic impact assessment methods are benefit-cost and internal rate of return analysis. In this study Benefit-cost analysis will be used. It is a method of comparing the benefits from a project to the costs incurred to conduct the project. The benefits are calculated as the dollar value of benefits received by the users of the research project's output. The costs are calculated as the sum of direct and indirect costs.

Since in any project costs occur before benefits, both costs and benefits should be calculated in present value terms. The value of the benefit-cost ratio may be greater, equal, or less than one. If it was greater than one, this means that the present value of benefits is greater than the present value of costs. This implies that the returns from this project are more than the money invested in it.

The economic benefits attributed to barley breeding programs are estimated as the additional production value that results from adoption of new varieties developed by the breeding programs. Three key parameters are needed to calculate this value: (i) the area planted with new varieties; (ii) the productivity gains associated with the adoption of these varieties; and (iii) the price of the crop (Morriset al., 2003). Productivity gains are often expressed in terms of yield per unit land area.

Gross economic benefit (GEB) model was used to calculate the benefits associated with the new varieties. The GEB formula is (Manyonk et al., 2003):

$$\mathbf{GEB} = \sum_{j=1}^{m} \sum_{I=1}^{n} (A_j * I_{ij} * Y_{ij} * P_{ij})$$

With

$$P_{ij} = p_{ij} / E$$

$$Y_{ij} = y_{ij} - L_{ij}$$

Where GEB is gross economic benefit, i =barley variety, j = location, A = area planted with new variety (ha), I = percentage of area cultivated to variety i, Y = yield advantage (kg ha^{-1})

P = crop price (\$ t^{1}), y = average farm yield for an improved variety (kg ha^{-1}), L = average farm yield for local variety (kg ha^{-1}), p = crop price in local currency, E = exchange rate of local currency to US \$.

Barley direct and indirect costs were structured by disaggregating ICARDA' barley projects budgets to conventional and participatory costs items; during the period 2000-2004 there were about 20 different barley projects conducted in ICARDA. These projects cover the expenditures of barley research in Syria and other countries. Some of these projects cover only conventional research expenditures, others cover participatory research only, and some of them are divided between the two program expenditures with different percentage. Each program's budget was constructed according to that and presented in table 1 for the period 2000-2004. The human capital investment in participatory and conventional research presents the highest proportion of these research investments. It constructs about 46% of the total cost for the study period; sometime it represented more than 70% of the total research cost in that year. The different cost items are presented in details in table 2.

The farmer's benefits were evaluated quantitatively and qualitatively. Economic benefits resulting from adopting a new variety that generate higher yield, greater stability, and improved sustainability. On the other hand, working together with researchers is assumed to improve the human capital of participating farmers. If work is done in groups or if information sharing is encouraged, then social capital, defined as the ability of farmers to work together and share information, may be increased as well (Johnson et al., 2001).

Individual interviews with farmers were assessed for the human and social capital impact. Changes in participants' knowledge and understanding of the trials, their interaction with researcher and other farmers, and their ability to diagnose the problem and solve it were assessed through a questionnaire.

Barley production costs for farmers under participatory and conventional programs are the same, since farmers use the same agricultural practices under the two programs. The production costs per unit of land is the same, while production costs per unit of output is less for farmers growing new varieties than those for farmers growing landrace varieties, since adopting new varieties increase agriculture productivity, and increase the efficiency of barley production.

The costs

The costs of the two types of breeding programs conventional and participatory at ICARDA were assessed through consulting with the breeders to specify the projects that are covering the participatory activities and the ones that are covering the conventional part of research. During the period of 2000-2004 there were eight projects covering the conventional research expenditures, five projects covering participatory research, and six

projects covering the expenditures of the two programs in different proportions. According to that the annual costs of each program was calculated for the same categories determined by the finance department at ICARCA. The costs of ICARDA conventional program in Syria consist of 15-20% of the whole conventional costs. For the purpose of this study, the lower limit of 15% of the conventional costs will be used to calculate the conventional cost for Syria. To get an idea about the distribution and the magnitude of the investment in human resource between the two types of breeding programs, the human resource cost at ICARDA was used. After specifying the staffs that have been involved in the two programs, the proportion of their time spent in each program was assigned and the cost for each program calculated (table 2). It shows that the personnel cost is the highest cost in barley breeding. The second highest cost item is the contract services cost which include labor that is hired to do most of the agricultural operation. Third item is the travel cost including local and international travel expenses and the perdiem.

The conventional costs of the national program can't be assessed now, since we don't have all the relevant data yet. Its assessment would be accomplished in the near future.

For farmers, the production costs under the two programs are the same, since; they keep their agricultural practices the same. The only additional cost farmers have to bear is the opportunity cost of the time they spent in planting, evaluating, and selecting the new varieties in the PPB trials. The number of these days is estimated to be 5 days for host farmers, and two days for evaluator farmers. For this reason, participant farmers were paid barley seeds as a subsidy for their time and land.

The benefits

The benefits of the programs can be calculated only if the three key factors specified previously are known. According to the survey, table 3 shows the percentage of barley area planted with improved varieties, and percentage of farmers planting them. The table shows that there are three provinces that don't grow any improved varieties because of the environmental nature of these provinces. Most of the land in these provinces has a marginal environment. And the second reason is participatory program in most of these locations has not reach the final stage yet. In Aleppo, it is clear that the adoption of improved varieties was a result of the participatory program. Edlib, Hama, and Raqqa are the earliest locations that adopted the improved varieties. And this is the case, because these provinces are in zone 2 which is considered as a favorite barley area, and second because there has been so much work in this area about dissemination of the released varieties. Total barley area is specified according to Syrian agriculture statistics, it was divided into two areas; the marginal area that the survey shows there is no adoption to any new variety in it, which assesses about 33% of the total barley area. The other part includes the rest of barley area that is about 67% of the total area.

Barley average yield for conventional and improved varieties, the percentage of barley area that is growing improved varieties and the percentage of farmers that are growing improved varieties were assessed through the farm survey and agricultural statistics. Average yield for participatory selected varieties were estimated using large scale

experiment farm data of the participatory program, two-average yield were estimated, one for the marginal area and one for the favorite area. For barley planted area with improved varieties, even if the collected data did specify the percentage of land that planted with conventional varieties, and the percentage that planted with participatory varieties, we still can't carry over this percentage to the national level since the participatory varieties still limited according to seed constraint. Average price for the study period in US$ / metric ton was used (164$/mt).

Benefits at the program level

A gross measure of economic benefits GEB will be calculated for the study period by taking into consideration the area planted to improved varieties developed by conventional and participatory research in favorable environment, as well as the benefits of the application of participatory in poor environment (marginal environment). Barley planted area to improved varieties will be calculated according to the national level information that are collecting from the national program. The yield advantage was specified as the difference between the on-farmers' yield of improved and local varieties, since large portion of the total area planted to barley was marginal land that does not suit any of the varieties released through the conventional program. The average yield of the varieties planted in marginal environment was lower than that of the favorable environment and will reduce the average yield of total area. For this reason the total barley area was divided into two parts in order to avoid the inconsistency of comparing yield gain results from the two breeding programs in marginal area. By dividing the area into two parts, the comparison will be between conventional and participatory varieties in each area. According to that the gross economic benefits GEB of the conventional program in the favorite environment can be estimated in addition to GEB of the participatory program for the two areas. And the impact of each program can be measured by the summation of the GEB in the two environments.

Participatory program that started in 2000 has released many varieties by the end of the 2003 season. There were three varieties released in Suran, Hama, Farmers named them by Suran and Nawaear 1&2. In Baylounan, Raqqa two other varieties were released, Raqqa 1 and Raqqa 2. However, by the end of the 2005 season, there were two more varieties were released in Baylounan area, Akrem and Kareem, and three more in Gern Al-Aswed,Raqqa, Yazin, Etihad and Salam. These varieties still are in seed production process. Therefore, there is not enough data about the adoption of these varieties. The only available information is about the amount of seeds that is available to farmers to grow this season. The benefits that can be generated by the new varieties can be calculated by finding how many hectors can be planted by the available seeds, then predict the total production and the total benefits (table 4).

To estimate the benefit-cost ratio, present value of the gross benefits and costs of the two programs should be calculated; commercial discount rate of 10% will be used.

The impact of plant breeding programs is not limited to yield advantage. In addition, improved varieties have important traits such as resistance to disease and drought. And

this has an important impact in reducing the risk associated with rainfed farming and thus helps farmers get stable income. Many other things are different between the two breeding programs. For the conventional program to release a new variety it takes nine years of research, and this variety may suit a certain environment only. While, in six years of research, PPB program can produce many different varieties suitable for many different environments. And, even in the same location farmers choose more than one variety that meets their preferences. Other point is that, the most important factor affecting the adoption of new variety is its performance, which varies with environment and management factors (Aw-Hassan and Shideed, 2003), and since the PPB research take place in the farmer's environment instead of research station, and use the farmers practices, it is very easy for farmers to be convinced and adopt the variety selected by them. This will prevent the society from spending additional cost to disseminate the new varieties. Also farmers will adopt all the selected varieties through the PPB program, because these represent their selections, satisfied their preferences, and suit their environments. For conventional research, many released varieties will not be adopted by farmers. And they can be considered lose to society that affect and reduce the GEB achieved by the program.

Breakeven benefits

Ex Post studies do not estimate the benefits to be obtained from continued investment in participatory program. An ex ante study will take place later to estimate these benefits. For now, economic investment in participatory research have been estimated, and benefits that would breakeven this investment will be estimated. The Estimated breakeven benefits and the barley price will be used to find the area that should be planted with selected barley varieties.

The same commercial interest rate of 10% will be used to inflate the annual investment in participatory program for the period of 2000-2004. To calculate the present value of the investment in PPB, the cost should be inflated to 2005 value. Because the money invested in 2000 has much higher value in 2005. The present value of investment was 636,771 dollars for the whole period (table 5). Barley production can be determined be dividing the present value of investment by barley price. The barley area to be planted by the selected varieties can be obtained from dividing the production by the average yield gain of the selected varieties.

Benefits on farm level

For individual farmer, his economic benefits can be estimated by calculating his yield gain of new variety per unit of land over the landrace variety, and multiply it by the area planted with barley and barley price. All the gain will be considered an economic benefit, since there is no additional cost associated with the adoption of the new variety.

Farmers may gain benefits other than the economic benefits, intellectual benefits. The knowledge that farmers get through their participation in the program improves their ability to make decisions regarding the variety testing and selection. About 81% of the

interviewed farmers stated that, even if the PPB research got into an end, they would keep practicing what they have learned about plant breeding and selection. They also assured that they would protect the new variety seeds, and would keep looking for good varieties with other farmers, and plant them. Up to 31% of those farmers said that PPB enhanced their experience in barley production, as well as in agricultural in general. Nearly 44% of them said that they gained new experience in variety selection through their participation in the evaluation and selection process. Some stated that their experience increased as a result of their interaction with other farmers, 21%, and their interaction with breeders, 27%. PPB program has a positive impact on the economic status and the livelihood of 65% of the farmers. The other 35% states that there is no change in neither their economic status nor in their livelihood resulting from being involved in the program yet. Most of those farmers are in the area where PPB has not got into final stage.

Through a question about the program benefits distribution, only 7% of the interviewed farmers believed that farmers who got the selected varieties should keep the benefits for themselves, while 93% believed that benefit should be distributed at community level.

Benefit-Costs Ratio

The estimated GEB shows that the gross economic benefit achieved by conventional plant breeding approach is 59.6 million dollars, for the period 2000-2004. Meanwhile, the Expected gross economic benefits for participatory research for the next season only are estimated to be 1.6 million dollars. This is representing the benefits achieved by planting the available seeds and about 4000 tons of Zembaka seeds that sold as feed not as seeds (table 4). The investment in conventional approach is less than the investment in participatory approach by less than 1% (when Syrian conventional research costs consist of 15% of the total conventional costs) for the same period, 472,999 dollars, and 477,247 dollars respectively. However, if the Syrian conventional costs considered any percentage higher than 15% of the total conventional costs, it will be higher than that of the participatory costs. Also, we observed that the present value of conventional cost is higher than the present value of the participatory costs, because the distribution of them over time is different.

The net present value for the two programs was calculated as the difference between the present value of the benefits and the present value of the costs of the two programs. It shows that for participatory program the present value of costs, inflated to 2005(table 5), was 636,771 dollar compared with the expected GEB of 1.6 million dollars to result a net benefits equal to .964 million dollars for this year only. The conventional program achieved, 30 million dollars in net benefits for the whole period (table 6).

The benefit cost ratio can be calculated after having the present value for benefits and costs of the two breeding programs. Results show that B-C ratio for conventional program is 68 and this is far away from 1. For participatory, B-C ratio of one year benefits is 2.5 According to these results, the benefits achieved by each of the two programs are much higher than the investments contributed to them.

It should be noted that costs of the national conventional program is not included in this study, since we are still working in the assessment of these costs. The inclusion of these costs will increase the total costs of the conventional program. And this will reduce the benefit cost ratio of the conventional program as well.

Conclusion Remarks

1. Farmers in marginal environment do not adopt varieties from conventional breeding. Thus, the only way to improve the livelihoods of farmers in this environment, where barley is the only grown crop, is through participatory breeding. Farm survey showed that farmers in this area have 0% adoption to conventional new varieties.
2. Farmers' participation in the participatory program has a positive impact at their economic status and their livelihood, as the study show 65% of the interviewed farmers stated that impact. However, the other 35% are living in areas where participatory research is in the middle stage.
3. The economic benefits of the conventional program are 68 times as much as the investment in the program. This is true if the comparison is between ICARDA costs and GEB, but, since there is other party involved in conventional research, the costs of the national program would be included to have a reasonable estimate of the B-C ratio.
4. To achieve the breakeven benefit for the participatory program, an area of 4045 hectors should be planted with the selected varieties of Raqqa 1&2, or an area of 1213 hectors should be planted with Suran or Nawaear1&2 or 9707 hectors of Zembaka. These areas determined according to the average yield gain of these varieties.
5. The expected economic benefits of the participatory program for next season are more than three times the whole investments in the program.
6. The potential area of adopting participatory varieties is 54.3% higher than the actual barley planted area. This is the outcome of a question, which was asked to farmers about the areas they are willing to plant with barley if the selected varieties seeds become available.

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Tables

Table 1: Costs of Conventional and Participatory Plant Breeding Program at ICARDA in US Dollars.

COSTS	2000	2001	2002	2003	2004
SUPPLIES	*-35288	-74132	-59923	-94442	-151809
CONTRACT SERVECE	-95108	-107419	-69458	-187409	-214574
TRAVEL	-68411	-97714	-59433	-64188	-72936
REPAIR&MAINTENA	-5355	-6870	-16468	-6221	-59247
MISCELLANEOUS	-13494	-44851	-28166	-7888	-31251
TRAINING	-10193	-2705	-5856	-2793	-11242
INTER.DEPT.ALLOCATION	34823	2000	97264	7159	0
DEPRECIATION	-7943	-5780	-3856	-5210	-5178
UTILITIES, RENT, COMMUNICAT	-5546	-2943	-3256	-4135	-7234
SALARIES	-218260	-258168	-266580	-232600	-283653
EMPLOYEMENT COST	-123043	-167428	-159369	-124515	-182274
GRAND TOTAL	-547818	-766010	-575101	-722240	-1019398
TOTAL CONVENTIONAL COSTS	-475844	-647319	-477539	-637680	-914937
SYRIA CONVENTIONAL COSTS	-95169	-129464	-95508	-127536	-182987
PATICIPATORY COSTS	-71974	-118691	-97561	-84560	-104461

* Following the ICARDA budget the (-) sign used for spending.

Table 2: ICARDA human and financial investment in barley breeding programs

Table 3: Percentage of barley area and barley farmers under improved varieties.

Year / Location	2005		2004		2003		2002		2001		2000	
	%F[a]	%A[b]	%F	%A	%F	%A	%F	%A	%F	%A	%F	%A
Aleppo	29	16	35	17	18	8	0	0	0	0	0	0
Edlib	33	33	24	31	24	29	10	18	5	13	5	16
Hama	63	70	63	69	63	62	44	421	42	41	38	27
Hassaka	0	0	0	0	0	0	0	0	0	0	0	0
Raqqa	50	47	40	22	30	19	30	14	20	12	20	12
Daraa	0	0	0	0	0	0	0	0	0	0	0	0
Swaida	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Average		24		15		13		7		6		5

(a) %F, is percentage of farmers grow new varieties.
(b) %A, is percentage of area grow new varieties.

Table 4: Amount of available seeds, seed rates, planted area, average yield, gain in yield and barley production and gross economic benefits for PPB.

Category	# Of staff	Annual costs (US$)			%Of time spent In PPB	% Of time spent In CPB	PPB cost	CPB cost
		Average salary	Employment.cost	Total				
P level staff								
P6	1	70875	65205	136080	0.2	0.8	27216	108864
P5	1	49203	45267	94470	0.1	0.9	9447	85023
Post Doc.	1	24000	1800	42000	0.25	0.75	10500	31500
NPO	1	12500	6000	18500	0.2	0.08	3700	14800
NPO	1	12500	6000	18500	0.9	0.1	16650	1850
NPO	1	12500	6000	18500	0.05	0.95	925	17575
GS5	2	4540	1861	6401	0.05	0.95	640	12162
GS6	2	5262	2157	7419	0.2	0.8	2968	11856
Total Costs				341870			72046	283630

Varieties	Amount of available seeds (ton)	Seeding rate (kg/ha)	Area to be Planted (ha)	Average yield (ton/ha)	Gain in average yield (t/ha)	Gain in barley production (tons)	Expected gross economic benefit ($)
Suran	4	200	20	4	3.2	64	10496
Nawaear 1	3	200	15	4	3.2	48	7872
Nawaear 2	1	200	5	4	3.2	16	2624
Raqqa 1	20	100-120	175	1.32-2.2	0.52-1.4	168	27552
Raqqa 2	15	100-120	136	1.32-2.2	0.52-1.4	131	21484
Zambeka	2000	150	13333	1.2	0.4	5333	874667
Total	2069		13684			12843	944695

Table 5: Annual costs and inflated annual costs for participatory breeding program in US

Year	Barley Total Area (ha.)	Barley Marginal Area (ha.)	Barley Favorable Area (ha.)	% Of Area in New Variety[a]	Gross Economic Benefits	Annual Costs	Discount Rate	Present Value of Benefits	Present Value of Costs	Net Present Value
2000	1316890	434573.7	882316.3	0.025	2705483.4	71377	1	2705483.38	71377	2634106.4
2001	1302760	429910.8	872849.2	0.03	9871091.8	97098	0.9090909	8973719.796	88270.909	8885448.9
2002	1234000	407220	826780	0.035	14146470	71631	0.8264463	11691297.38	59199.174	11632098
2003	1253600	413688	839912	0.065	5372077.2	95652	0.7513148	4036121.076	71864.763	3964256.3
2004	1253600	413688	839912	0.065	5372077.2	137241	0.6830135	3669200.978	93737.45	3575463.5
2005	1253600	413688	839912	0.12	22177036					
					59644335	472999		31075822.61	384449.3	30691373

dollars.

Year	PPB Annual Costs	Discount Rate	Inflated Annual Costs
2005		1	
2004	104461	0.90909	114907
2003	84560	0.82644	102318
2002	97561	0.75131	129854.5
2001	118691	0.68301	173776
2000	71974	0.62092	115915
Total	477247		636770.5

Table 6: Gross economic benefits, annual costs, present value for benefits and costs and

Net present value for conventional breeding program at ICARDA in US dollar.
[a] The % of area planted with conventional varieties only.