Lessons learnt from the Socio-economic Impact Monitoring of a Scientific Project Oriented towards Poverty Lessening through the Development of Three Open-pollinated Seed Varieties Resistant to Tomato Leaf Curl Virus (ToLCV) in South India

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1. Introduction

Since 1996, the University of Agricultural Sciences in Bangalore (UASB), India, the Natural Resources Institute (NRI) of the University of Greenwich, United Kingdom (UK) and the Asian Vegetable Research and Development Centre, (AVRDC), Taiwan, have been conducting scientific research oriented to understand the Sustainable Management of ToLCV disease and its whitefly vector, *Bemisia tabaci* (Genn.) in India in the context of a poverty alleviation programme. This virus has a dramatic effect on farmers' ability to grow tomatoes and has seriously affected their livelihoods for almost two decades. In fact, the whitefly and the plant viruses it transmits, have achieved worldwide prominence, due to the enormous yield losses they cause in tropical and sub-tropical crops such as cotton, cassava and many vegetables including tomato.

Thus, in order to find a suitable solution to assist farmers to grow tomatoes in the south of India in 2002, and after 6 years of scientific research, three new types of virus-resistant open-pollinated seeds were developed by the partnership of the UASB, NRI and AVRC. Later, in the same year, and after official approval of the Indian Government, the three resistant seeds – Nandi, Sankranthi and Vybhav were released commercially. This was therefore one of the first university scientific projects within the UASB to venture into the selling of a technology to various stakeholders including the private sector.

The trajectory of the project which initiated a scientific research that culminated in a successful marketing of the seeds has been one of the most interesting processes. Along with that process various stakeholders such as farmers, researchers and private companies participated and took keen interest at various stages of the project. The present article is a discussion of this process both in terms of the monitoring approach used by the project to assess impact and, second, some of main results and lessons learnt along the way.

2. A Monitoring Approach to Enhance Impact in a Research Project

Recent decades have witnessed a growing convergence in the global agenda on development research as evident from the consensus-based International Development Targets (IDTs) and the various agreements reached through the recent United Nations Millennium Summit. This evolving consensus has been accompanied by an increasing emphasis on results[1]; that is, in seeing

[1] The use of results based management frameworks by OECD countries public sectors, various development co-operation agencies and donor agencies at macro scale is nowadays a very common practice in the context of "aid fatigue" around either development programmes or research on development programmes. Making an adaptation of the results framework at the "fascinating" scale of this project, the implementers made an effort to develop a monitoring system in order to i) regularly collect data on actual results, ii) integrate evaluation observations that would complement the performance information available and iii) use performance information to learning and decision making. (For more details on results based management frameworks, see Annete Binnendijk, Results Based Management in the Development Co-operation Agencies: a Review Experience. http://www.oecd.org/dac/evaluation

research development programmes and projects demonstrate more effectively the purpose and value of the products their research. Stakeholders in developed and developing countries alike want to know how effectively development research interventions contribute to make people's lives less harsh.

To meet the challenges, development research programmes and projects increasingly use a range of tools to monitor and assess progress towards the achievement of their results and, the respective, lessons learnt. The Crop Protection Programme, funded by the Department for International Development (DFID) in the UK, has an international programme working in Africa and the South Asia regions and represents part of this effort. It is considered by DFID that agriculture still underpins most rural livelihoods (DFID, 2002) and national economies. In this particular case through the ToLCV project this programme sought to benefit low-income farmers through the application of new knowledge in the area of crop protection, since a lot of poverty is still caused today simply by the loss of farmers' crops due to pests and plant diseases.

Overall, the ToLCV research project has lasted for 10 years in which three distinct phases can be characterized, although these phases overlap with each other. In the initial phase the project concentrated on the collection of data on the ToLCV epidemic and tested potential management practices that could be used by farmers to combat it. In the second phase the focus of the project was on the development of the ToLCV-resistant varieties, because that was the technology demanded by the farmers. In its third phase, the project besides its continued scientific research characterizing more elements related to the ToLCV virus, it was also concerned with strengthening of the dissemination and promotion of the main research results: the three resistant varieties. Part of this work was to focus on monitoring and evaluation to collect data to assess the socio-economic impact of the project.

Without excluding the work from the first phase, this article focuses mainly on the last two phases that were more concerned with the dissemination and promotion of the research results. This paper considers the way how the project went on with its monitoring approach to enhance its socio-economic impact when disseminating and promoting its results. Also it has brought about some reflections on the lessons learnt, which could serve as an innovative experience for other scientific projects working in the context of developmental issues i.e. poverty lessening. Similarly, institutions such as research organisations and universities could benefit from this experience especially under the current context of having to be organisationally more effective with the dissemination and promotion of research products. While there is a wide body of work on organizational effectiveness, and the role results-based management plays in such effectiveness, there is less documentation available on the linkages between dissemination and promotion of research results and organizational effectiveness.

In terms of the project itself, once the second phase was initiated in 2002 and culminated basically with obtaining the three open pollinated resistant varieties, the implementers, the Plant pathology Department of the UASB and NRI, continued to dialogue with all the old and new organizations or actors that had a potential role in the project during the new phase. This was constructed as having two main strategic dimensions.

The first dimension comprised of basically the clarification of a set of interrelated though differentiated activities pertinent to the project implementation for this phase. That is the projects' PROMOTION --encouragement to stakeholders in Karnataka and other states to use the ToLCV resistant seeds--, its DISSEMINATION --spreading information about the ToLCV resistant seeds--, its DELIVERY --"Passing of the technology (seeds) through an uptake pathway--," (its UPTAKE – South Indian farmers using the ToLCV resistant seeds) and its ADOPTION (the ToLCV resistant varieties integrated into the regular farming of farmers). The definitions used here to obtain some clarification of the main task as per the interest of the various stakeholders were taken from Garforth & Norrish (2000). Table 1 below illustrates the basic matrix used as guidance for this first activity.

TABLE 1 WHICH ACTORS, FOR WHAT?

Dissemination and promotion of research results **Actors**	**Promotion** (Encouragement to stakeholders in Karnataka and other states to use ToLCVs)	**Dissemination** (Spreading information about ToLCVs)	**Delivery** (Passing technology through an uptake pathway)	**Uptake** (Farmers using the ToLCVs seeds)	**Adoption** (TolCV seeds integrated into regular farming of farmers)
Seed Companies	Are they involved in promotion? If yes, how?	Are they involved in dissemination? If yes, how?	Yes, how and where?	Yes, how and where?	Yes/No?
NGOs					
Public extension services					
University					
Farmers					
Credit Institutions					
Government agencies					
Mass media (TV, radio, newspapers)					

The second dimension meanwhile was constructed around the identification of an implementation strategy of the project including its expected "in- built" impact(s)[2]. The concept of impact here was not something to wait for until the end of the project but something that could be thought of as being generated continuously.

Moving some distance away from the conventional impact approaches that "measure impact" after implementation, in this case the idea was to "think impact" before it could happen. In particular the notion used was 'impact path'. Ravindra (2000)[3] mentions this concept to refer to the identification of project interventions in terms of three stages: 'outputs', 'development gains' and 'well-being gains'. These three stages relate closely to a result-oriented approach. The three stages distinguished three types of results (outputs, outcomes and impact), and can eventually help to visualise 'the path' along which a project after some time is leading. In fact, it is here that monitoring impact paths could provide good opportunities for fortification or modification of actions since the 'impact path' could be either going in a constructive or unconstructive manner or anticipated or unanticipated way. To quote:

> "At each stage of the impact path, impacts should have the necessary strength to manifest at higher levels of impact. There is a gestation period involved in manifestation of impacts at higher levels. Depending on the strength and gestation period involved, impacts are visible only at certain levels, i.e., individual farmer level, watershed level, block or district level, etc., referred to as the 'resolution level'. Finally, not all the stakeholders are subjected to the impacts; impacts have a definite stakeholder focus" (Ravindra, 2000).

The identification of not only an impact but 'impact paths[4] according to various stakeholders certainly helped in the recognition of actual and potential impacts without any difficulty for this particular phase. Graphic 1 illustrates an outline that was designed from the very beginning of the project about the main impact paths. Here, it was meant to invite the scientist mainly at this point to think about the project impacts. Since scientists in some occasions have a different worldview and role in research projects, the main idea here was to invite them to think about some of the current and future social and economic effects of their research product --the three resistant varieties. The corresponding graphic of this brainstorming was printed out and displayed in the project's office as a kind of "symbolic" reminder to all those involved in the

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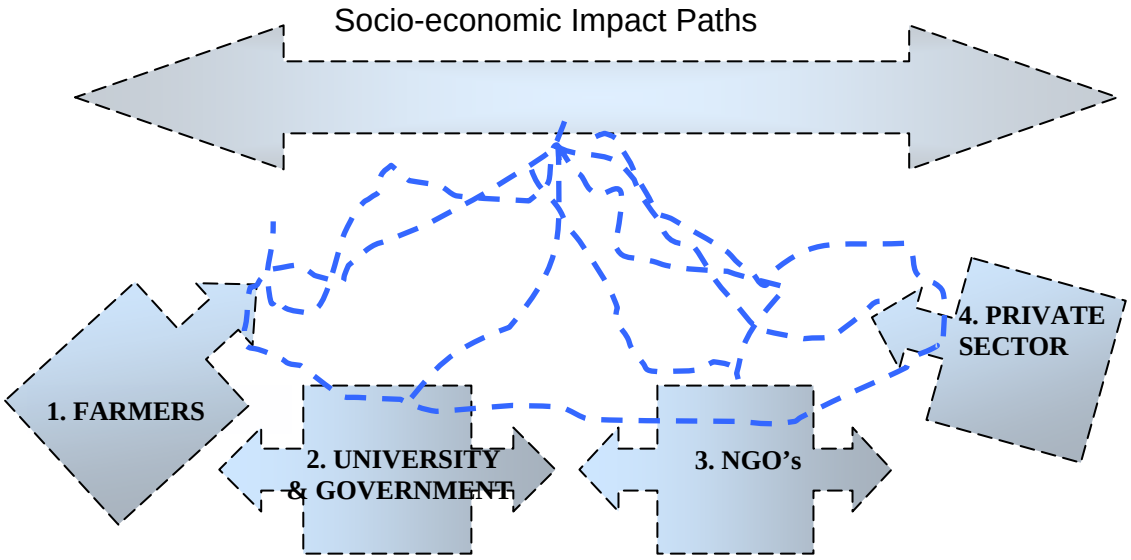
[2] In the context of the project, impact in general was understood as a systematic analysis of the sustainable or significant changes --whether encouraging or discouraging and expected or unexpected—in peoples' lives and other stakeholders brought about by a given action or series of actions performed by a research or developmental intervention.

[3] A Ravindra, (2000), Impact Assessment Framework for Community-based Natural Resource Management. The Agha Khan Foundation, India

[4] The model presented by A Ravindra is more complex and it involves the use of indicators and attributes. The project however did a tailoring according to the circumstances since in many occasions the use of indicator becomes another lengthy and complicated activity itself. The idea here was to be efficient in the use of few concepts that will allow in a fast manner to think the impact paths.

implementation. As it was discussed later with a group of scientists, this proved to be an interesting reminder in their lab!

Graphic 1. Impact Monitoring Model



This initial graphic though uncomplicated came to symbolize various issues and it was important to think not only about the impact paths but also about the maximization of work through each path to visualize and achieve what could and should happen at that moment. The non-straight lines represented, for example, open space for flexibility the project should have in respect to what could happen as contrary to what will happen for sure. In itself this was a concept different from that of the logical framework[5] that works from a linear perspective of cause-effect when concerned about results. In a similar way, as suggested by Ravindra, the idea about impacts as per actors helped to visualize some achievable and "straightforward" impacts. This, in particular was and is an important issue since nowadays with the emphasis on project impact(s), implementers get conceptually bewildered in the process of translating them into something achievable within the reality of a project either in the short, mid or long term.

Thinking strictly about the main set of activities as per actors, in terms of monitoring of the socio-economic impact of the promotion and dissemination of the three resistant varieties ---- Nandi, Sankranthi and Vybhav, the main ones seen as significant at this point were as follows:

[5] Critically examined nowadays for lacking flexibility and missing important aspects of processes and relationships in an intervention 2005, the logical framework has to be complemented with other tools since by itself it is an insufficient tool to take care of the complexities and nuances of a project. See Woodhill, J., (2005), M & E as Learning; Rethinking the Dominant Paradigm. Book chapter prepared for: Monitoring and Evaluation of Soil Conservation and Watershed Development Projects to be printed by World Association of Soil and Water Conservation, 2005.

1. Farmers

A socio-economic baseline survey with a group of 75 farmers was undertaken in 2003, with the purpose of having a profile of the Karnataka farmers who would be the potential users of the seeds. This was done also with the idea of contrasting the situation before and after the seeds became available commercially.

A set of four farmers' Monitoring Groups were closely followed up since 2003 and according to circumstances of the availability of water. The main purpose here was to try to estimate more adequately the costs and benefits when cultivating the three resistant varieties as compared to others as well as to assess the performance of the three project varieties with the farmers.

2. University and Government

With the purpose to monitor the impact of the seeds on low income farmers, two units of the UASB were invited to join the project. These were: The National Seed Project (NSP) and the Agricultural Technology Information Centre (ATIC) which are in charge production, promotion and commercialization of seeds. For the project the partnership with them was important since the seeds were developed in the Plant Pathology Department by plant pathologist and not by the traditional breeders or seed technologists. The monitoring agreed with these partners consisted basically of tracking down of the name of the buyer, his or her location, the variety of the seed bought as well as the amount.

3. NGO’s

A group of NGO’s working on rural issues in the areas of Karnataka and Maharastra were contacted with the purpose of helping in the promotion and dissemination of the seeds.

4. Private Sector

The monitoring tools used with the private sector were regular visits, phone calls as well as the distribution of brief questionnaires from time to time in order to know the performance of the seeds. In order to get the information about the performance from the various seed companies buying the seeds, the UASB had to prepare a legal agreement in which the companies will commit themselves to share the information regarding the performance of the seed and its use. The agreement was signed at the moment of buying the seeds.

Once the above set of activities were defined and discussed regarding the monitoring of impact of the project with the various stakeholders, those were implemented. However, during their implementation some remained unchanged and some others were modified. Since the main focus of this paper is to discuss and to document the monitoring approach used by the

project, the discussion below addresses the main results and the lessons learnt along the process.

3. Major results and lessons learnt regarding the Monitoring of Impact(s)

Before starting with the description of the main results and lessons learnt with respect to each impact path selected at the beginning of phase two, it has to be added that the project had an evaluation review in 2004 by the project managers of the DFID's portfolio, Natural Resources International. This exercise, in as much as it was a value added activity, brought to relief some important dimensions of the project impact(s) that were not fully foreseen in the initial discussions. Among those, one was the policy impact at the state and national levels generated by the project and the other was the research impact itself through a collaboration of north-south research bodies. In the corresponding description of results and lessons these issues will be included. Hence, the results including the impacts and the main lessons learnt are described below as per the various group of actors presented in graphic 1.

3. 1 Results and Lessons Learnt with the Farmers

The socio-economic baseline: A socio-economic baseline survey with a group of 75 farmers was undertaken in 2003 with the purpose of having a profile of the Karnataka[6] farmers who were the potential users of the seeds. Also with the idea of contrasting the situation before and after the seeds would be available commercially. Thus, the main objectives set up for this task were respectively:

- To establish the socio-economic characteristics of a representative group of Karnataka farmers who currently produce open-pollinated and hybrid tomatoes that are not resistant to ToLCV;
- To estimate social and economic determinants of the tomato farmers' livelihoods such as assets in their possession, production costs, income, and marketing as well as to assess some institutional constraints; and
- To utilise the report as a baseline for appropriate future comparisons when the farmers would be using seeds resistant to ToLCV.
- An identification of the main impacts (environmental, social, economic and poverty alleviation) that the project might achieve in the medium and long run.

The socio-economic baseline survey found its justification in the fact that either from the production side or the consumption side, tomato plays an important role in the farmer's household economy in Karnataka and part of Andhra Pradesh. In particular, in the context of the project, it was assumed that the new seeds offered an option to low-income farmers in the face of dramatic economic losses caused by the ToLCV. This ToLVC pushes farmers to use high amounts of pesticides with its adverse effects on the health of

[6] Karnataka is the second producer of Tomatoes in India and the main focus area of the project.

both the consumers as well as producers of tomato. Thus, summarizing some of the significant findings[7] of the baseline, they are the following:

The average farmer out of the 75 farmers consulted for the baseline survey in this part of India showed that he is 42 years of age, married and in majority of cases he is also the head of the household. In addition, he does not possess expensive production technology such as a tractor, a tiller or a cultivator. Instead, he possesses at least 1 ox plough and in few cases a bullock cart or a crasher. Regarding his livestock the same average farmer owned in average one or two oxen and one or two buffaloes. In 2003, it has been gathered that the same average farmer, cultivated six hectares of land in total and one hectare per crop. This is indicative of the use of land by the average farmer.

With respect to production of crop and its marketing, the average farmer responded that the three most important crops for them in terms of income were paddy (rice), tomato and sugarcane, in that order. Similarly, responding to what proportion of the total household income comes from crop sales, a little more than half of farmers considered that the entire household income came from this source.

The fact that a high proportion of farmers depend significantly on crop sales for their household income was a finding highly revealing by the baseline[8]. This fact associated to the tomato's fragility as a crop, together with the lack of infrastructure for its storage and processing, came at this point to be a problem gaining in complexity that went beyond the just the ToLCV disease. For example, the farmers' frustration during the first season of tomato sales in 2004 came as a result of price instability. Unlike in the case of sugarcane in which government provides minimum prices, no such government role is prevalent in the case of tomatoes, resulting in wide oscillation in prices (between Rupees 5 per kilo and 50 paisas a kilo in the case of the open-pollinated variety) in a matter of days within the same season.

Hence, the project in this context found a possible link to policy issues, related to horticulture. If some government agencies could plan in a participatory manner with the farmers, crop cultivation and marketing, these farmers in this part of India would certainly improve the benefits through better regulation specially when it is clear that many of them derive their income from the production and marketing of a combination of vegetable crops such as tomato, brinjal (egg plant), chilli, ragi, cauliflower and jowar.

In the specific case of tomato, its sales represented one quarter of the total income acquired from all crops sold for more than half of the farmers. A "fast"

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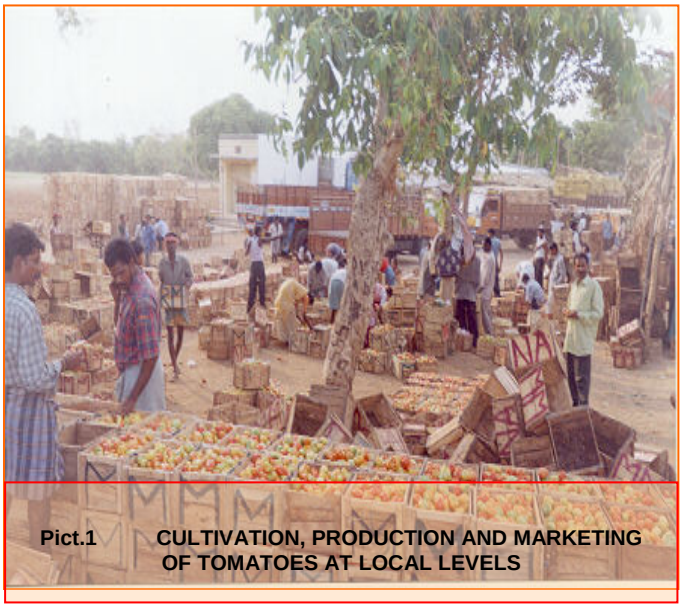
[7] For more detailed information and statistics see the baseline report: Moreno, Nagaraju and others,2003, Economic Baseline Survey of Farmers Growing Open-pollinated and Hybrid Tomatoes in Karnakata, India

9 In order to have a better idea about sources of income the survey asked for secondary sources besides the selling of crops. Less than half of the farmers recognised themselves as having other sources of income including the selling of animals, processing of primary products, trade, crafts, income from services or wages from farm work. However it has to be said that more than half of them did not answer this question properly.

cash crop, tomato by itself could not, therefore, be expected to represent the highest proportion of the total income from crop sales. Nevertheless, farmers perceived the tomato crop as important in the context of the whole household economy because it has the potential of yielding a reasonable return within a short period (four months).

And here the difference between marketing hybrids and open-pollinated[9] tomatoes was seen as another revealing finding having a lot of significance. While the first type is more commercial in its scale and is cultivated by wealthier farmers, the second type is cultivated by more local, low income farmers with smaller pieces of land (representing lower scale economies), leading to different potential commercial returns.

An additional notable difference was also offered between the consumed and marketed amounts of open-pollinated and hybrid varieties. The farmers showed their clear preference for open-pollinated tomatoes for their own consumption and hybrids for sale. Farmers consider that hybrids sell better than the open-pollinated because they are more resistant to long distance transport; people in the cities prefer them because of their appearance although they are less tasteful when eaten, and are less flavourful. In contrast they consider open-pollinated tomatoes to be tastier, to have a good flavour for the preparation of sambar and other sauces, though more fragile for long distance transportation, and its cultivation is less expensive.



Pict.1 CULTIVATION, PRODUCTION AND MARKETING OF TOMATOES AT LOCAL LEVELS

In terms of the responsibility about who takes care of the crops in its cultivation, production and marketing, the survey also showed some clear differences. Whereas both men farmers and women farmers take care of the crops at the planting, cultivation and production stages, it is mainly the men who take care of the marketing of all crops in general and tomatoes in particular. It is clear from the survey that men are the ones who maintain the links with the markets mainly and the markets are the ones located either at home, village or district level. The respondent farmers seemed unwilling for

[9] Two types of tomato seeds used by the Karnataka farmers were discussed in the baseline survey. They are open-pollinated and hybrid seeds. The first type is a seed which produces offspring just like the parent plants in a “true” breeding process. The second type is a seed resulting from the crosses of distinctly different parental lines in a more artificial or induced manner. Open-pollinated seeds allow tomato growers to harvest and save seeds for the next production season. This is not possible with the hybrid variety.

the urban and more distant marketing of the tomatoes. It was only in the case of sugarcane that the farmers interact with an industry.

Regarding farmer's expenditure as in contrast to income, the survey followed the general methodological recommendation that is better to ask people about what they spend instead of what they receive. In the specific case of the survey, for example, the question about secondary sources of income did not work well. Thus, to have a better idea about the household economy, the survey inquired about type of expenditure, its frequency, the average of amount spent, and who was perceived as responsible for the expenditure. This is illustrated in table 2.

TABLE 2. TOMATO'S FARMER PRIMARY SOURCES OF EXPENDITURE IN KARNATAKA

PRIMARY SOURCE OF EXPENDITURE	RESPONSIBLE	AVERAGE SPENT	FREQUENCY
1. Food	Men and women	64.71 Indian Rupees	Almost all farmers stated that mainly daily
2.Children's education	Mainly men	655 "	Almost half of the farmers stated that each six months
3. Health services	Mainly men	466 "	More than half of the farmers stated that each six months
4. Clothing	Men and women	2635 "	Almost half of the farmers stated that annually
5. Production inputs	Men	976 "	Almost all farmers stated that mainly monthly
6. Wages for labourers	Men	499 "	More than half of the farmers stated that weekly
7. Religious	Men	607 "	More than half of the farmers stated that quarterly
8. Social occasions Wedding, deaths	Women and men	18,582 "	No specific frequency was mentioned as these tend to be infrequent events

There were additional noteworthy findings related to the farmer's household economy. First, the item that represented the highest expenditure came via social occasions and the one that had the highest value was weddings. In India where weddings are socially constructed as a primary societal ritual, the importance of them plays an important role in the economy of the poor households. In the specific case of the rural areas, for example, many of them get into big debts to be able to marry their children. Thus, if the sale of crops is uncertain, this certainly has a negative impact in the household economy.

Second, the relationship among expenditure, health matters and tomatoes was more significant than usually associated. The farmers spend quite a lot of money buying pesticides to kill the whitefly vector of ToLCV. During discussions with them prior to the baseline it was observed that the farmers were using pesticides 7 to 8 times during a crop cycle lasting 80 days on average in order to manage ToLCV. Thus, the high expenditure and the consequent negative health impact in the farmers that applied the pesticides as well as the consumers who eat these tomatoes were among the most significant findings brought to light by the survey.

The paradox here was that the statistics seemed quite “normal” and without any problem. It does not reveal how little awareness there is about the relationship between health and tomatoes among producers and consumers. Almost all men and women consulted in the survey recognised they sprayed their tomatoes with pesticides and only less than half of them acknowledge using some type of safety protection while spraying. And despite the fact that almost half of the farmers did not use protection when spraying, they did not describe any health problem possibly related to the use of chemicals for spraying; neither had they visited a health provider.

In sharp contrast to this situation the new resistant varieties released by the project bear a remarkable impact in terms of environment and health. The open-pollinated varieties can be grown without the use of pesticides and, at most, farmers would spray only 2 to 3 times for a crop that lasts 80 days on average.

Third, during 2003, all 75 survey farmers experienced at least one disease or pest in their tomatoes and, for counteracting that, all of them used chemicals. In effect, almost all farmers acknowledged the pervasive presence of ToLCV. However, at the moment of the survey almost all farmers did not have information about the existence of resistant seeds to ToLCV. Thus, when asked, the farmers mentioned as the most significant sources of information about tomato production mainly five. Respectively they were chemical dealers, extension services, seed companies, experienced farmers, family members and radio and TV.

The fact that the farmers did not have any information about the existence of resistant varieties undoubtedly came to be the biggest justification for the baseline at the same time the project’s challenge in terms of the future comparison once the project ends. However, since the baseline data was gathered through a questionnaire which had limitations, there was the need to get additional data about aspects of the production, cost, and distribution of tomatoes in relation to their livelihoods. It was then, in that context, that some groups of farmers were monitored closely to have a better picture of these realities.

The Monitoring of Farmers’ Groups

As it has been described earlier, as part of the activities to monitor the impact(s) as per actors, a set of 3 farmers' Monitoring Groups were closely

followed up since 2003. This was done according to circumstances of the season, the availability of water; farmers wish to collaborate with the project and weather conditions. The main purpose with these groups was to try to estimate more adequately the costs and benefits when cultivating the three resistant varieties as compared to others as well as to assess the performance of the three project varieties according to the point of view of the farmers. Another purpose was to complement detailed data-gathering activities that would offer an alternative to the limitations of the Baseline questionnaire as a social technique.

Thus, since 2003 at least 6 farmers groups were formed and followed up. However, for different reasons only 3 were successfully in terms of the appropriate monitoring of the performance of the seeds[10] and the corresponding data gathering. Also the average number of farmers who cooperated till the end of this activity in each of the 3 successful groups were 9 farmers out of 15 or 20 who started in each group. Common reasons for the groups and farmers that were not successful in the monitoring of the seeds were the lack of water (either rainfed or through irrigation through various seasons), proper care of the plants and data gathering. Interestingly something that was observed across the groups was the fact that the slightly wealthier farmers took the participation more seriously and also kept notebooks for their records. On the contrary, the farmers less wealthy showed more difficulties coping with the monitoring of the seeds. Perhaps the less wealthy needed more support by the project. But this in itself was a constraint on the project, since research projects, due to lack the financial means, can not afford to have a person working on a regular basis with the farmers.

The three groups that concluded the participation in the project successfully were found in the three different locations. The first group was in Halabudnur and Kudalakuppe (Mandya) and Naganahalli and Kalasthavadi (Mysore); the second one in Kaggere, K.R. Nagar (Mysore); and the third one in Madanapalli, Palamnar and Punganur (Chittur, Andhra Pradesh). The groups using the three resistant varieties for the first time, were interviewed in average three to four times while the cultivation was going on following three basic tools: the questionnaire used in the baseline, a checklist designed to follow their livelihood issues and a detailed monitoring form about the cost of cultivation of the project varieties and two other contrasting open-pollinated varieties such as PKM and Ruchi. Significant findings, interesting to be addressed and summarized in the context of this article are as follows:

The five basic problems that the farmers experienced as sources of vulnerability besides ToLCV disease were (arranged in order of their importance): water scarcity, price fluctuation, fruit borer and wilts, irrigation problems and electricity. Though focused on ToLCV mainly, the project was found itself learning about all these issues in order to be more effective.

A depiction of the tomatoes by the farmers themselves was gathered. According to them, tomatoes represent a crop activity mainly at *besigele kala*

[10] The project seeds documented are Nandi and Sankranthi. Vybhav although distributed to some farmers, did not offer confident data.

(summer) and only in a few cases as a *kharif* (rainy) or *chaligala rabi* (winter) crop, although with the increased use of hybrid seeds, tomatoes can be cultivated during the whole year. It is also a crop which requires sufficient irrigation. Similarly, they prefer the tomatoes to be of big and medium size in both types of seeds, i.e, open-pollinated and hybrids. In a similar fashion they preferred the tomatoes to have a thick skin and be firm.

Regarding shape they prefer the tomatoes to be round, --in the case of open pollinated tomatoes round with ridges, and in the case of hybrids, round tomatoes without ridges. In fact, while monitoring one of the earliest and recurring observations that came as an unexpected result was regarding the ridges. Farmers would have like Vybhav, Nandi and Sankranti to have ridges because not having the ridges made them look like hybrids! This unexpected assessment by the farmers came even after some participatory breeding exercises were done with them at the very beginning of the project, when the seeds were being developed.

With respect to characteristics such as sourness and sweetness of tomatoes, the farmers preferred sour and sweet tomatoes. Thus, here the choice was clear: open-pollinated tomatoes for self-consumption and marketing and hybrids mainly for marketing. They like sour tomatoes for the preparation of sambar and other spicy sauces, this being a characteristic of open-pollinated tomatoes in contrast to the hybrids. The sourness is, furthermore, better appreciated if it is complemented with sweetness.

Concerning tomato seeds a noteworthy finding through the baseline and the groups was the fact that the farmers in general do not self-reproduce seeds anymore for any vegetable. In the specific case of the three resistant varieties developed by the project it was because the farmers did not know that they could reproduce it. It was a task of the project to inform the farmers that they could self-reproduce the seeds. This, in fact, was an additional task very significant in terms of poverty lessening since the reality for many farmers is that they have to buy seeds because they cannot self-reproduce them. Hybrids, which are the source of market of many seed companies, cannot be self-reproduced and, therefore, the farmers have to keep buying seeds. On the contrary open-pollinated seeds in general can be self reproduced and in particular the three resistant varieties developed by the project.

A more detailed picture of the livelihoods of the farmers, and complementing the one mapped by the baseline, showed that in general the farmers, who were interviewed, own their houses which are usually constructed with bricks. And they have electricity and for water supply, in an average, a bore well per household. In a similar manner, the farmers owned a radio and in few cases, a TV. Regarding means of transport, the most common means used by them were either walking or bus. It was only in a few cases that they own a motorbike.

Interestingly enough in general the majority of farmers at the moment of the interviews stated they did not have loans. Only in few cases they have a long term loan with a co-operative bank. This in itself was a good finding since

loans from middle men in many rural parts of India are one of the most oppressive sources of debt for many low income farmers. A similar interesting finding was the self sufficiency experienced by almost all the farmers with regard to food production and the high level of involvement in experimentation of new crops though various types of groups. Participation in self-help groups by the women and on agriculture committees by men was a commendable degree of participation. In fact this can be seen as an additional explanation for the participation of various farmers in the tomato project.

Selected aspects of interest regarding the cost and benefits when cultivating tomatoes were the cost of inputs, costs of harvesting, cost incurred due to tomato diseases, and the ratio of benefit when doing the project seeds and other two open pollinated seeds such as PKM and Ruchi.

For instance, almost all farmers bought open-pollinated (non-resitant to ToLCV) and hybrid seeds and they obtained them from urban dealers. The same is true for all the other inputs such as farm yard manure (FYM), fertilisers, pesticides, stakes and threads. The farmers buy many of these inputs and, on many occasions, they pay significant amounts of money to acquire them. Table 3 shows the averages paid annually for various inputs when the farmers use various seeds such as Nandi, Sankranthi, PKM and Ruchi.

Table 3. ANNUAL AVERAGE COST PER INPUTS FOR TOMATO CULTIVATION USING VARIOUS SEEDS

	Annual Average of total amount paid (Rupees)	**Annual Average of total amount paid (Rupees)**		**Annual Average of total amount paid (Rupees)**	
	As per Baseline data	**As per the three Groups data Project seeds**		**As per the three Groups Data Other open –pollinated seeds**	
Inputs	**Various seeds**	**Nandi**	**Sankranthi**	**PKM**	**Ruchi**
1.Open pollinated seeds	1,311	1200	1200	100	240
2. Hybrid seeds					
3. FYM	770.71	891	1,096	723	862
4. Fertilisers	1,681.49	1,172	1,486	832	633
5. Pesticides	1,517.81	469	1,215	1,188	1,145
6. Stakes & Threads	722.22	867	1,521	109	0
TOTAL	9,766.43	4,599	6,518	2,952	2,880

As the table 3 shows the difference in the price between the Nandi and Sankranthi seeds on one side and PKM and Ruchi on the other is due to the fact that the original price of the two first seeds was high as they were not yet available commercially at the moment that the data was gathered. Also the difference between the high price of fertilizers for Nandi and Sankranthi as in contrast to PKM and Ruchi was related to the fact that the second type of seeds, once are infected with ToLCV they are not given any care. It was observed during the field visits that once the farmers observed that the plants are infected, they just left them in the fields without any care. Further, the

money spent in pesticides came significantly low in the case of Nandi but not so much in the case of Sankranthi. However in general the amounts for the farmers that used Sankranthi in Andhra Pradesh were higher for all items as cost of inputs were higher there than in Karnataka.

Observing the next important items, which are the total cost of cultivation of open-pollinated resistant and non resistant seed varieties to ToLCV as well as the yield obtained per acre, tables 4 and 5 respectively illustrate the average differences in cost of cultivation by acre per year as well as the average tomato yield obtained by kilogram per acre as gathered by the farmers in the three groups.

TABLE 4. AVERAGE TOTAL COST OF TOMATO CULTIVATION USING OPEN-POLLINATED RESISTANT AND NON RESISTANT SEEDS TO ToLCV DURING 2004/2005

FARMERS GROUP 1 INDIAN RUPEES			FARMERS GROUP 2 INDIAN RUPEES			FARMERS GROUP 3 INDIAN RUPEES		
Nandi	PKM	Ruchi	Nandi	PKM	Ruchi	Nandi	Sankranthi	PKM
10,766	6,744	8,512	11,897	6,703	7,785	15,443	18,341	13,180

TABLE 5. AVERAGE OF TOTAL YIELD OBTAINED AFTER CULTIVATING OPEN-POLLINATED RESISTANT AND NON RESISTANT SEEDS TO ToLCV DURING 2004/2005

FARMERS GROUP 1 KILOGRAM/ACRE			FARMERS GROUP 2 KILOGRAM/ACRE			FARMERS GROUP 3 KILOGRAM/ACRE		
Nandi	PKM	Ruchi	Nandi	PKM	Ruchi	Nandi	Sankranthi	PKM
9,062	1,982	2,185	8,744	2,222	2,465	7,400	8,265	3,333

Table 4 and 5 show very well that although the farmers spent approximately between 4,000 to 5,000 Indian rupees more cultivating Nandi and Sankranthi than PKM and Ruchi; they obtained almost four times more tomato fruits per acre with Nandi and twice with Sankranthi than with PKM and Ruchi.

This contrasting trend in money spent cultivating various seeds in relationship to yield obtained was and is among the early and constant ones. This trend was also the evidence of the good performance of the seeds and one of the most significant impacts of the project. And it became more and more prominent when calculating the total income obtained and the net profit as the table 6 next displays.

TABLE 6. AVERAGE OF TOTAL INCOME OBTAINED AND NET PROFIT AFTER CULTIVATING OPEN-POLLINATED RESISTANT AND NON RESISTANT SEEDS TO ToLCV DURING 2004/2005 BY THE THREE GROUPS OF FARMERS

	FARMERS GROUP 1 INDIAN RUPEES			FARMERS GROUP 2 INDIAN RUPEES			FARMERS GROUP 3 INDIAN RUPEES		
	Nandi	PKM	Ruchi	Nandi	PKM	Ruchi	Nandi	Sankranthi	PKM
TOTAL INCOME OBTAINED	18,958	7,800	7602	21,861	7,780	8,627	32,000	50,536	16,333
NET PROFIT	8,192	1,055	410	9,963	1,077	842	16,556	29,278	3,153
RATIO	1 time	7 times	19 times	1 time	9 times	11 times	2 times	1 time	9 times

The net profit ratio cultivating and marketing Nandi seeds in relationship to PKM and Ruchi respectively were quite significant. As table 6 shows in the first group for the farmers to get 8,192 Indian rupees of net profit they have to cultivate Nandi seeds only once while PKM seven times more and Ruchi nineteen times more. Similarly, for group two to have the same results as of one crop of Nandi, the farmers have to cultivate PKM nine times more and Ruchi eleven times more. Finally, in group three for one crop of Sankranthi, the farmers have to do almost twice a cultivation of Nandi seeds and nine of PKM. This sharp contrast between the number of times and net profit makes evident, of course, the main result of the project which is to get the farmers to use seeds resistant to ToLCV.

In concluding this section about the results obtained with the completion of the baseline report and the monitoring of the three groups of farmers, it is important to make explicit some of the few lessons learnt by the project by working with farmers.

MAIN LESSONS LEARNT AROUND THE BASELINE AND MONITORING IMPACT WITH FARMERS

- The model of monitoring impact has to be relatively uncomplicated, so that everybody could use it in a friendly manner. In this way, scientists get to appreciate the social, political and economic dimensions of their scientific work. In the project some of the young scientists felt uncertain at the beginning but later they appreciated that they were being exposed to dimensions that their routine task do not allow them.
- The social technique of questionnaire while doing baselines has to be complemented with techniques that provide more in depth data. The initial baseline did not allow the project to appreciate fully all the possible economic, social and health-environmental impact(s) of the project. Only after frequent visits and interviews with the farmers all those issues emerged more clearly and were taken into account.

- Particular problems arise in the context of questions related to income earned or lost, or expenditures on inputs or production activities. Farmers tend to be doubtful of the destination or use of the information given. This is the case despite clarifications that it would be used for social research purposes only. It has been found that questions on expenditure receive more adequate responses than questions on income. In designing the questionnaires the expenditure item has to be emphasised more than the income item as a general recommendation for this type of surveys.
- It is important in scientific projects to differentiate the techno-scientific aspects from the social ones since the two imply different subjects. In the context of the project one part was the work with seeds and another one was with farmers. So, as a result of these two views there was some conflict at the beginning of the project since some scientists thought that it was possible to have some farmers control groups between the ones using and the ones not-using the seeds. This type of research in the context of poverty alleviation programmes is being questioned for its ethical dimensions. Thus, it was after some discussions that the methodology of the groups was decided in a flexible and voluntary basis with the farmers instead of a laboratory experiment!

3.2 Results and Lessons Learnt with the University and the Government

Once the project was working on the monitoring of the impact with the farmers through the baseline and the monitoring groups, it was necessary simultaneously to think about the monitoring of impact(s) of all the other activities implemented by the project within the university and in relation to the government. Thus, with this purpose a set of new practices were proposed by the project. Again, although quite straightforward, the significance of those practices came from their value in terms of "thinking impact" around the work already done and the work to be done in future. The three basic activities and practices, that can be characterised as communicational included the following: the strengthening of key partnerships within the university; the organisation of a website as a way of systematizing and displaying all the work done by the project for almost a decade, the elaboration of two fliers—one for the farmers and one for policy makers -- and, lastly, a promotional video about the main results of the project.

<u>Organisation of key partnerships within the UASB</u>

Although work among and between different departments of the UASB is performed on a regular basis, the difference of the work done in this occasion through the project came from the fact that in order to monitor the impact of the seeds on low income farmers the two units (The National Seed Project (NSP) and the Agricultural Technology Information Centre (ATIC)) in charge of production, promotion and commercialization of seeds, were invited to monitor the distribution and selling of the seeds. They were also invited to think more strategically about the sustainability and plans for large scale distribution of the seeds. For instance, the experience of pricing the seeds to be sold to the farmers had to be revised from the original prices (40 Indian rupees for 1 gram of Vybhav and 30 for one of Nandi and Sankranthi) in April 2004. Once the project realised that the price of the seeds were not

favourable to the farmers, the prices were revised (20 Indian rupees for 1 gram of Vybhav and 15 for one of Nandi and Sankranthi). As the baseline and the work with the farmers group showed the scale of open-pollinated seeds is local and more related to low income farmers than hybrids that relate to wealthier ones. Thus, it was clear that the focus of these two units should be on the livelihoods of the low income farmers through the open-pollinated seeds. As it will be discussed later, the focus of the seed companies in contrast was the development of hybrids mainly from the three project seeds. As table 7 shows up to April 2004 through these two units 456, 464 and 1498 grams of Nandi, Sankranthi and Vybhav were either sold or offered in Krishi Melas and Field days as part of the promotion and dissemination activities.

TABLE 7. AMOUNTS OF SEEDS EITHER SOLD OR PROMOTED AMONG FARMERS BETWEEN 2002/2004 BY PROJECT PARTNERS

ATIC GRAMS			NSP			NSP-GOVERNMENT OF KARNATAKA KRISHI MELAS AND FIELD DAYS		
Nandi	Sankranthi	Vybhav	Nandi	Sankranthi	Vybhav	Nandi	Sankranthi	Vybhav
60	100	--	271	264	938	125	100	560
10 farmers			49 farmers			38 farmers		

The fact that the monitoring was done through keeping records of the amounts sold, the name of the farmer, his or her location introduced a new practice in the handling of specific projects since through it the money obtained for the seeds sold was being kept in a specific bank account. Further, it was decided that the money obtained will be used in more seed production and promotion. This was in part done to guarantee some sustainability of the project. As it was stated before, this is among one of the first projects within the UASB that ventured in the selling of a technology to various stakeholders. Thus, this type of impact in changing practices in the way projects are implemented within the university has value at a time when these institutions are being asked to be more resourceful. Through the project some experience has certainly been gained.

The website

Disseminating the results of a scientific project in general is commonly performed through papers, publications and conferences. Thus, in this project as any other scientific project these tasks were being implemented. However, the new task oriented towards strengthening the monitoring of impact in this case consisted in designing and organising a website in which the project results will be displayed to the general audience at the same time also to a scientific audience. Thus, around the organisation of the components of the website the project made an inventory of all documents completed as table 8 demonstrates as a brief example.

TABLE 8. SCIENTIFIC WORK IMPLEMENTED UNDER THE SONSORSHIP OF THE TOMATO PROJECT

ACTIVITY	RESULT
1. Scientific papers published	8 Abstracts/ 23 papers
2. Master in Science (M. Sc) and Philosophy Doctoral' theses (PhD). Department of Agronomy Department of Genetics and Plant Breeding Department of Seed Science and Technology Department of Entomology Department of Plant Pathology	 2 M. Sc 6 M. Sc/ 2 Ph. D 2 M. Sc 1 M. Sc 15 M. Sc/8 Ph. D
3. International Conferences	18

Independently of the numbers that by themselves are significant, what table 8 shows is the collaborative effort, on the one hand, among various departments with the UASB and the corresponding capacity building, and on the other, the collaboration between north and south research institutions since NRI and UASB disseminated the results across the globe by participating in conferences. Data collected on epidemiology, alternatives hosts, the TolCV resistant varieties developed and the identification of B biotype in India, are all achievements of the project, made evident through the above works.

To make them visible and accessible to various audiences, the abstracts of the all the theses were displayed in the website. This in itself was a new practice for a University in India where this type of information is kept in the shelves of libraries without much impact! The same was done with papers published and the abstracts of the conferences in which the project has been presented.

Additional components displayed in the website are as follows:

- A visual history of the project through a collection of photographs. In many research and development projects the photos remained in the desks of implementers!

- A brief written history of the main events of the project with the purpose to translate scientific work in a common language.

- A list of the seed companies that have bought the project seeds and a list of the donor institutions as well as the managers of the research program to which the project belongs.

The website can be appreciated in the following address http:// www.tomatoleafcurlandwhitefly.org

Finally, to give some sustainability to the website, it will eventually be hosted under the umbrella of the main website of the UASB. It was suggested to UASB that this could be a pilot case for the UASB to display similar projects. Again, all this work in the context of pushing for impact and modifying

practices in scientific and technical projects and institutions working towards the lessening of poverty.

Fliers

Two fliers were prepared by the project in the context of the last phase and in the context of the promotion and dissemination of results. Starting with the one addressing the farmers, the main idea was to offer them information about the performance of the three seeds as well as the main characteristics of the varieties which were resistant to the deadly virus. This first flier was elaborated by the NSP and in many ways became the equivalent of the promotional flier that many private seed companies use to promote their products. The quality of pictures, paper and text were given attention. The project was trying to avoid the concept of low quality materials that many public institutions produced, in many cases, to be distributed to low income farmers.

The second flier was another very new practice within the project. Targeting decision makers through an informative flier has to demonstrate the basic facts, especially some clear evidence between the links between tomatoes and the economy in the context of poverty lessening. Thus, the flier called attention to the fact that the Indian economy despite its growth continued to experience lower growth rates in agriculture when compared to other sectors such as manufacturing and services. This was especially striking since agriculture provides the main source of livelihood to over two thirds of India's population. In the case of tomato production in India, this crop is a high value exportable as well as an important subsistence vegetable grown by farmers from different economic status. So the need for the government to think more carefully about it was raised. Again for a research project this was a new dimension to add to the routine scientific work.

The promotional video

A video documentary called "Sustainable Management of Tomato Leaf Curl Virus and Whitefly on Tomato in India" was produced and released at the project's workshop.

LESSONS LEARNT AROUND DISSEMINATION OF RESULTS BY A SCIENTIFIC PROJECT
• The main lesson learnt by the project comes basically from the reinterpretation of the work done around traditional scientific and technical activities. Many of the traditional activities done such as publication of papers, elaboration of theses, conference presentation and even collection of pictures were seen as in need of taking a different communicational role. This role was, furthermore, related to the demonstration of evidence of impact and visibility in times of low resources to public institutions and need of innovative practices. "Thinking Impact" took the project team to think in the maximization of work and establishment of linkages in the various activities the project was implementing for years already in a more effective communicational way.

3. 3 Results and Lessons learnt with NGO's

Around a group of 5 NGO's working on rural issues in the areas of Karnataka and Maharastra were contacted with the purpose of helping in the promotion and dissemination of the seeds. However the efforts were not successful. The co-ordinating work required a constant effort but unfortunately the project did not have either the financial or the human resources to pursue the work in this front.

LESSONS LEARNT AROUND DISSEMINATION OF RESULTS BY A SCIENTIFIC PROJECT
• The lesson learnt by the project in its co-ordinated work with NGO's came through the need to create awareness about the different although complementary work between research on development and development projects. NGO's in general do not get involved in research directly and universities do not get involved in the day to day activities directly with rural communities. Thus, the need for complementary work between these two types of institutional roles is however not yet fully understood. And at the end of the day the ones that suffer the consequences of this lack of co-ordination are the low income rural communities.

3. 4 Results and Lessons learnt with the Private Sector

Regarding the impact monitoring of the project with the various seed companies as it was explained before various tools were designed for this. They were respectively visits, phone calls as well as the questionnaires informing about the performance of the seeds and as per the legal memorandum of agreement. Thus, the interesting results about this activity is that till June 2005 eleven small and mid size Indian seed companies had bought the seeds developed by the project, going beyond the initial modest expectation that only two or three companies will buy the seeds. Thus, this anticipated result of the project came as another very positive evident impact. Again in the context of new partnerships between universities and private sector in order to augment impact(s) in terms of poverty lessening, this activity had a lot of meaning.

Additional traits important with these results were the size of the companies and the amount of money paid for the seeds. First, through the monitoring with the companies it was observed that they were small or mid size and therefore were still in the process of being consolidated as business. Consequently, their interest in the partnership was enthusiastic as in contrast to the few multinational companies that decided not to be part of the partnership.

Second, the initial price fixed by UASB for the seeds that were going to be used for commercial purposes were 7,500 Indian rupees for two grams of Vybhav seeds and 5,000 for Nandi and Sankranthi seeds. The eleven

companies went ahead and paid for the materials. Thus, as Table 9 shows till June 2005 the project has sold 59 grams equivalent to 173,750 Indian Ruppes which came to contribute more to the future financial sustainability of the project.

TABLE 9. INCOME OBTAINED BY THE TOMATO PROJECT SELLING THE THREE OPEN POLINATED RESISTANTS VARIETIES TO THE PRIVATE SECTOR

UASB SOLD SEEDS		
GRAMS		
Nandi	Sankranthi	Vybhav
19	19	21
TOTAL 59 Grams equivalent to 173,750 Indian Rupees		

Until June 2005 the seed companies reported that they were not experiencing the ToLCV disease and, also the majority of them stated that they will try the three resistant varieties mainly in the development of Hybrids. So, far none company confirmed the use of the seeds in developing open-pollinated seeds.

The future impact(s) once the hybrids will be available in the market and reach many South Indian farmers --low income and wealthy ones—this will be an added result to the ones already documented in this article. This however would have to be performed by the stakeholders interested in the impact in the long term of a research project like this since the project is planned to end in January 2006.

LESSONS LEARNT AROUND THE WORK WITH THE PRIVATE SECTOR

- The main lessons learnt by the project in its work from the private sector came from the sharing of material at very early stages of the research. In 2004 and 2005 there was the perception that the market was offering already seeds resistant to ToLCV. So, this situation took the project to think increasingly that perhaps from the very early exchanges of information with the private seed companies, they acquired the resistant traits without due acknowledgement to the project. So, if some companies got the resistance trait that will explain why there were resistant varieties already in the market. The demonstration of this perception has however to be proved. Since it seems complicated to demonstrate it, what seems important to address is, then, the lesson learnt when working with the private sector. Beside knowledge, the private sector requires profit and this sometimes takes it to behave in an advantage position. So, universities have to learn to be more careful with how they share their knowledge with the private sector on the one hand, and, on the other, how they can think along lines of better profit generation plans. So far the project experience provides satisfaction since this is a pioneer project in which a university's department (Plant Pathology) has sold a newly created technology (ToLCV-resistant seeds) to the private sector.

3.5 Conclusions

To conclude, the main purpose of this article has been to discuss and document the process of monitoring the project which was being implemented in order to enhance its socio-economic results (including impact (s)) as well as some of main results and lessons learnt along the process. Developing a model to monitor the impact as it comprises the various stakeholders and possible impact(s) paths, the article tried to describe the trajectory of initiating a scientific research project that has culminated in a successful marketing of the three resistant varieties of tomato seeds-- Nandi, Sankranthi and Vybhav.

In relation to the farmers, the articles discusses and tries to show evidence of the main data findings of a baseline survey applied in Karnakata and the detailed gathering of data around monitoring the cost and benefits of using the three resistant seeds with three groups of farmers in Karnataka and Andhra Pradesh. This was done with the purpose to list positive expected and unexpected impact(s) of the project in terms of health, environment and livelihoods to the farmers in the South of India.

Next, the article discusses the communicational approach used with the project within the context of the University and the State government and international research institutions. It was shown that the systematization of information produced when displayed on a website can help to the dissemination of scientific research and technical projects not only to the scientific community but also to the general public.

Subsequently the article describes briefly the not very successful experience of working with NGO's. Finally, the article shows the main results obtained by working in partnership with some small and mid-size seed companies. The experience showed that eventually some co-ordinated effort can be done between public research and private research and that this could get to benefit low income farmers if their problems are fully understood.

The articles closes by pointing out that due to the development of hybrids from the three OP varieties, tomatoes can be grown successfully by all types of tomato grower, even in the peak of the ToLCV-epidemic season, with greatly reduced pesticide use and associated benefits to the poorest farmers, consumers and the environment.

Reference

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