Andhra Pradesh Netherlands Biotechnology Programme for dyland agriulture: Mid-term evaluation of second phase

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ANDHRA PRADESH NETHERLANDS BIOTECHNOLOGY PROGRAMME FOR DRYLAND AGRICULTURE

MID-TERM EVALUATION OF SECOND PHASE[1]

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1 Introduction

The Andhra Pradesh Netherlands Biotechnology Programme (APNLBP) is one of the four country programmes supported by the Ministry of Foreign Affairs, Government of the Netherlands. The broad objective of the programme is to contribute to poverty alleviation through biotechnologies. The Programme follows an interactive bottom up approach in programme implementation. The first phase of the programme started from 1st November, 1995 and concluded by 31st March, 2002 with a total budget of Rs.155 millions. On the basis of a satisfactory performance evaluation, the Programme was extended for another five years up to 31st March, 2007 with a total budget of Rs.275 millions. Thus the total duration of the programme has been more than 11 years with a total outlay of Rs.430 millions. During the period between 1995 and 2005 the programme established about 75 research projects with a total commitment of about Rs.300 millions in association with a number of research organizations and non-governmental organizations, State government departments in Andhra Pradesh. Details on these points may be seen in Tables 1 - 3 in the Appendix.

The programme has been evaluated twice in 1996 and 2001 by external evaluation teams. The present one is thus the third in 10 years. It was conducted over the period October 3rd to 10th 2005. Its conduct and timing are part of an obligation to the Government of the Netherlands to have a mid-term evaluation during its second phase. The overall objective of this evaluation has been to assess the structure and procedures of the programme, the results obtained and its impact on poverty alleviation and sustainable development among smallholders, with special reference to the districts of Mahaboobnagar and Nalgonda. In particular, the evaluation was asked to assess the extent to which the programme has secured the participation of the end-user in programme formulation and its implementation and how this has affected the programme as a whole. It was asked to examine the achievements of the programme vis-à-vis these objectives and identify strengths and weaknesses. The evaluation was also asked to suggest scope for its extension in the future.

The evaluation report has been structured as follows. Section 2 outlines the broad methodology adopted by the evaluation team. Section 3 provides a brief summarised account of the inception and historical development of the programme. Section 4 goes on to present summary observations on the progress made on its various approved projects in relation to their broad objectives. These observations pertain to both scientific and technology development performance of the individual projects. Section 5 goes into details of human resource development stimulated by the programme while Section 6 explores governance aspects. Section 7 outlines recommendations while the final section suggests an institutional structure for the future. The Appendix provides information on the evaluation team, further details on the projects themselves, institutions visited and persons met, financial details and the programme schedule of the evaluation team.

2 Methodology

The evaluation team was asked to consider the following aspects of the programme:

- Its history, objectives and approach
- Its organisation and management (including the monitoring of projects)
- Its outputs and impacts on end users
- The extent of collaboration and convergence with other country programmes
- Its future viability, structure and requirements

To this end the team met and held discussions with a range of institutions and individuals. Details of these may be seen in the Appendix but in summary they consisted of principal investigators and participants in projects, the chairman and members of the BPC, the leader and staff of the BTU, representatives/leaders of stakeholder bodies such as NGOs, research institutions, university departments, government bodies, and representative farmer groups. Visits were a mixture of laboratory visits (to hear presentations and to interact with staff), visits to field sites (field research stations, NGO headquarters and villages) and visits to other concerned organisations. Additional information was obtained through desk analysis of the records made available by the BTU Secretariat. All information sought was made available to the team.

3. Brief Historical Background

It has been the strong belief of the Dutch public policy since early 1990s that the potential of agricultural biotechnology can help redress problems of food insecurity in developing countries provided these countries are empowered to design their own technologies to suit their local conditions. With this objective in view Dutch assistance was made available to India, Colombia, Kenya and Zimbabwe. These country programmes were constructed around three elements; the integration of the developmental aspects of Dutch biotechnology policy; collaboration with four countries; and international coordination and cooperation. A significant feature of these programmes from their inception was that they should be owned and executed by local steering committees having representatives from many stakeholders. Thus unlike most internationally funded research projects, their research agendas have been derived from the felt needs of local communities. In addition research has focused on crops, resistances and properties that differ from those invested in by the MNCs. In this respect research forms a counter balance - from the perspective of food security and sustainable farming by small farmers in developing countries - to such threatening developments as the use of terminator genes, the exclusive attention given to herbicide resistance, "biopiracy or gene tourism" and the one-sided representation of interests in the (international) regulation of biosafety and intellectual property.

The Indian Programme focuses on Andhra Pradesh, one of the States where Dutch Development Cooperation is strong. It is implemented in the name of Andhra Pradesh Netherlands Biotechnology Programme for Dry land Agriculture (APNLBP) and has evolved over a period of time. After two years of elaborative preparatory phase the substantive phase began from November 1995. From the beginning its unique feature was that it should follow an interactive bottom up (IBU) approach, an approach based on the principles of participatory technology development (PTD). All projects and programmes were to be formulated on the basis of local needs assessment and priority setting, in which end users, researchers, policy makers, government and non-government organizations should be involved. In addition a central principle was to be constant interaction between farming communities and scientists in the process of technology development and adaptation. These interactions would be used to combine indigenous knowledge of people with modern scientific knowledge.

Using this (IBU) process a multi-disciplinary team consisting of natural scientists, social scientists, extension workers, administrators, and NGO representatives participated in a local "need assessment survey". This led to intensive discussions and deliberations in prioritizing specific areas for intervention in dry land agriculture. The output of this survey resulted in a base document for designing the entire programme and defining the priority areas in a priority-setting workshop wherein different stakeholders participated and deliberated. Its broad objectives were as follows:

1. To promote application of biotechnologies relevant to small scale agricultural producers and processors in A.P. in such a way as to contribute to sustainable agricultural production taking into account in particular the position of target groups such as women and poor farmers.
2. To develop appropriate biotechnologies through research activities that focus on identified priority problems.
3. To conduct supportive activities required to ensure development and adoption of biotechnologies including training, transfer of technology activities, workshops and information dissemination.
4. To strengthen capacities of local organizations in A.P. to develop and transfer biotechnologies and conduct analysis in the field of technology assessment.
5. To promote the adoption of biosafety measures and to contribute to discussions on issues of intellectual property where appropriate.

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The programme began in 1997 and has since focused on four priority areas. These are (i) agroforestry and horticulture (ii) food crops (iii) oil seeds and (iv) animal production and health. It focuses mainly on a few selected villages in Mahaboobnagar and Nalgonda districts. All technologies developed through this programme are being tried initially in these villages and their impact assessed. The plan is that proven technologies will then be propagated in other parts of the state.

4. Progress of Projects

As outlined above, the project mission has been to improve the income generation and quality of life of the people living under the harsh and drought prone rural conditions of Mahaboobnagar and Nalgonda districts of the Telangana area of Andhra Pradesh. The programme aims at productivity increases of castor, sorghum, pigeonpea and groundnut by quality seed production and molecular genetic approaches, organic matter recycling, vermicomposting, and biological control of insect pests and diseases. Income diversification of farmers is addressed by feed development, cattle improvement, other relevant animal husbandry activities, and silvipastural and hortipastural systems. The programme has upstream research to develop transgenic crops and relevant downstream activities to make the villagers open to the adoption of simple technologies that can increase the productivity of their crop and animal husbandry related activities. This approach has opened the minds of capital-starved farmers to simple locally available technologies and thus has prepared them to accept at a later date even higher order technologies such as transgenic crops. Progress of different components of the project is summarised below.

Andhra Pradesh is the single largest user of chemical pesticides in the country and a lot of it is used for crops including pigeonpea, castor, sorghum and groundnut. The addiction to pesticides has adversely affected the ecosystem and incomes of the farm families. Therefore the APNLBP felt it appropriate to address the need to reduce chemical pesticides and fertiliser use and find viable alternate technologies. Progress in various projects is discussed below.

4.1 Encouraging botanical pesticides through local resources:

Locally at village level there occur a number of plants with insecticidal and insect repelling properties. These can be deployed in biological control of crop diseases and pests and make potential components of integrated pest management (IPM). Indigenous Traditional Knowledge has been documented by experience rather than through experimentation. For this reason the project made an attempt to collect several samples of neem (Azadirachta indica) from different parts of the country and estimated the level of azadirachtin (*aza*) present. Experiments were conducted on factors such as the role of soil, age of tree and sunny side of the branch to select elite accessions with stable high aza content. There was significant variation in the aza and the best clones were validated, micropropagated through tissue culture and several thousands of them were planted in various villages. A neem clone CRI 8/97 that contains better and higher levels of aza was registered as a genetic stock with the National Bureau of Plant Genetic Resources, New Delhi vide their INGR No: 03038 dated September 2001.

This renewable pesticide bank of neem adds income to the rural women who collect the neem kernels to extract oil, which is used for pest control purposes. Similarly *Pongamia* and *Anona* (Custard apple) seeds are collected and the seed oil is used as a botanical pesticide. In the horti-silvi pastoral aspect of the programme several Anola trees have been planted and seed supply for oil extraction may not be a limitation. There were agencies extracting and making available these oils for spraying of field crops to check insect damage. The team noticed that farmers are aware and are practicing the use of botanicals spray at a given dose as part of IPM. As a result the overdependence on shop driven chemical pesticide for insect control has been downsized. This has provided jobs and income to several people and has conserved the environment as well.

4.2 Biological control of pests:

There are a number of microbial organisms in nature that parasitise insects and plant pathogens. Also insect parasites and predators establish a natural balance of organisms in an unsprayed crop. Only occasionally does the pest population explode. When this happens chemical control becomes inevitable. Till that time promoting natural balance through biocontrol systems is the most sustainable IPM technology. After a series of experiments it was observed that *Trichoderma viridie* strain B-16 and *T.konningii* strain B-19 are the most adapted and effective to control castor wilt (*Fusarium ricini*) and grey mould (*Botritis ricini*). The KVK and many of the NGOs were educated on the mass multiplication and application of these biocontrol organisms in several villages covering many farmers and a few hundred acres of crop. The effectiveness of the technology is shown by the fact that micro entrepreneurs are now mass multiplying these biocontrol agents and marketing them at village level. Farmers have also learnt the art of seed treatment with biocontrol agents. Effective strains of Trichoderma viridis and other beneficial nitrogen fixing and phosphate solubilising bacteria are now routinely applied in these villages. The crop stands were robust and green in such cases.

Extensive screening of phyllospheric and rhizoplane bacteria has led to the isolation of new strains for biocontrol and biofertilizers. An example is a strain of Serratia marcescens, effective in control of late leaf spot in groundnut. The mass multiplication of the NPV virus, granulosis virus and Bacillus thuringiensis strain Bt-5, their formulations developed by the upstream research institutions, field validation and convincing pest control observations have encouraged several hundred farmers to go for this cocktail of biocontrol agents application to control heliothis, semilooper and other pests affecting castor and pigeonpea. The Trichograma card + NPV/Virus popularized in 15,000 acres of land spread over 20 villages is a large operation to demonstrate the utility of the technology. The pheromone traps for ground nut leaf minor has also been effectively operationalised. Similarly for other Lepidopteran pests like heliothis such traps are used. It was noticed that farmers do periodic scouting of their fields, identify pests and their stage of development, and are able to decide on the IPM steps/ actions to be taken.

Terminal field activities are impressive. And it was noted that farmers are excited about biocontrol and biofertilizer systems and their multiple uses in insect pest and disease control and nutrient augmentation. Backed with better varieties of castor, pigeonpea and sorghum pesticide use has been substantially reduced. This will also reduce the contamination of the village water bodies with pesticides and nitrates. In this way the integrated biocontrol technologies demonstrated by the Sri Arabindo Rural Institute, KVK and in Mahaboobnagar district by various NGOs, and the delivery of simple science based solutions to the pesticide problem has promoted new micro-entrepreneurial ventures. The ever open communication channel between technology developer – technology multiplier / manufacturer – and the technology user was conspicuous at all sites. It was effective and relevant to the knowledge intense biocontrol operations.

Enthusiastic farmers have become leaders in practising biocontrol as a component of IPM and through word of mouth have spread among village farming communities the benefits of biocontrol, vermicompost and hortipastural technologies. Neighbouring villagers have started visiting the lead village to learn the technology by paying a learning fee to the village collective fund. The concept of Village Bioresource Centres is highly appreciated by the review team. Apart from imparting training, promoting micro entrepreneurs, supply of pure cultures and spawn such centres serve as science windows for farmers, children and graduate trainees.

4.3 Production and use of biofertilisers

At several places biofertilizers are in use. Unavailability of soil phosphate is a serious problem in drylands. Thus biological approaches that may enhance nutrient uptake, solubilise soil phosphates, improve micronutrient and physical status of soils can contribute substantially to dryland agriculture. Micro-biofertilizer factories have been established by young boys and girls using the technology and the concession the APNLBP has extended for setting up of such rural units. The nitrogen fixing bacteria for legumes and phosphate solubilising bacteria for all crops have been integrated into production systems. Some of the farmers have started using urea chemical fertilizer coated with neem oil to allow slow release of nitrogen and reduce the fertilizer dose. Neem, pongamia and castor cake are used as organic fertilizers for sustaining agricultural production by using village waste and reduce chemical inputs. The overall village ecosystem concern for sustaining agricultural\production has caught imaginations and farmers are seeking a technology to have high yields with optimal input usage. The biofertilizer factory run at SAIRD (and the adjoining farm) is commendable and villagers can see the application of science in indigenous farm input manufacture. The reduced cost of inputs enhances farm incomes and inputs become locally available at the correct time when needed. This timely availability of input saves time and results in higher farm production.

4.4 Promoting quality seed production:

Several hundred farmers have learned the art of good quality seed production of pest resistant high yielding varieties such as Haritha in castor and LRG 41 in pigeon pea. Nucleus seed of these varieties should be preserved and multiplied for distribution all over the state.

4.5. Recycling farm organic matter waste:

In the project villages there are considerable levels of crop residue and animal droppings that go as waste. These are good sources of carbon and minerals in which soils are deficient. Vermicomposting alleviates these deficiencies. In many places visited, there was an overwhelming acceptance of this technology. Apart from creating well aerated soils, improving soil structure and increasing the availability of micronutrients, vermiculture fields had good crop stands. Several thousand farmers have now been trained and many of them are mass producing vermicompost or selling live worms (*Eudrillus eugeneae*). Vermicompost has virtually become a mass movement in the places visited. Around 5000 tonnes of vermicompost was produced in 170 villages.

4.6 Mushroom Cultivation

Recycling paddy straw by oyster mushroom cultivation in locally designed sheds has made excellent progress. It has given additional income to women and has extended nutritional security by way of food to the community. Marketing mushroom spawn and the mushroom themselves will also offer new employment opportunities to the youth and improve the nutritional status of the farming communities.

4.7 Transgenic crops and molecular markers for varietal improvement

Transgenic and marker assisted approaches comprise powerful tools to speed up crop improvement. To resource poor farmers, these can provide seeds as a package of easy-to-apply technologies. For low-input agriculture practiced in semi-arid regions the critical target traits are – tolerance to insect pests, diseases and water deficit. The farmers in drylands of Andhra Pradesh depend upon castor, sorghum, pigeonpea and groundnut for their livelihood. With this background, the APNLBP evolved ten projects aimed at developing transgenic cultivars relevant to this region. A majority of these projects were built to utilise the already known genes, as an available solution to the problems of dryland agriculture. Hence seven out of ten projects ware based on transgenics. Three projects (on pigeonpea and castor, summarised in a later part) aim at isolating native genes by approaches of functional genomics, molecular mapping and wide hybridisations. These components should be strengthened in third phase since by that time the research groups would have the mapping populations under development and would be better prepared infrastructurally to take up bigger challenges in molecular approaches. Since the dryland crops are not of major interest to private enterprise and are of lower priority in current international programmes, it will be timely if a higher level of support is provided under the APNLBP in the third phase to strengthen projects in functional genomics and marker assisted selection. Progress of the ongoing projects and suggestions are broadly summarized below.

4.7.1 Castor

Castor is an important crop for India, a country with globally the highest acreage under cultivation. It is predominantly grown in Andhra Pradesh, more often by poor and marginal farmers. Insect pests and diseases cause yield losses to the extent of 15-80%. The major pests are castor semilooper (Achaea janata) and tobacco caterpillar (Spodoptera litura). The important diseases include wilt and Botrytis grey rot. The APNLBP aimed at the development of transgenic castor for resistance to these insect pests.

During the first phase of the project, efficient in vitro regeneration protocols were developed and early studies were conducted to evaluate Agrobacterium and particle bombardment mediated transformation. During the second phase, two genes coding for δ endotoxins - cry1Aa and cry1EC were introduced to develop transgenic lines for resistance to the semilooper and tobacco caterpillar respectively. Seven T2 transgenic lines with cry1Aa and five T1 lines with cry1EC were developed, using a drought tolerant ruling castor variety DCS-9. RT-PCR, Southern hybridization and insect bioassays were conducted to establish cry1Aa transgenics. A total of five lines in the two classes were found promising by insect bioassays.

The review team found the progress highly encouraging. This is the first time castor transformation has been reported. The team however, lays emphasis on advancing more transgenic lines in both cases. Rapid methods for screening and advancing the generation need to be followed so that at least twenty independent transgenic lines with single copy insertions are examined for insect resistance by the end of 2006. These should then be grown in the field to analyse plant growth, development and insect resistance. By the end of 2007 several (at least 10 – 20) single copy, homozygous insect resistant transgenic lines should become available. Multiplication of seeds of the most promising lines should be undertaken to examine field performance. The project holds good promise for commercialization since castor is a non-edible crop with monotypic genus. This would simplify the biosafety tests necessary for GM crops. The review team recommends exploring partnerships with the seed industry and providing sufficient support through the second phase and beyond. The team also suggests the inclusion of suitable parent lines for transformation so that insect resistant hybrid varieties can be developed to give heterotic yield advantage also to the farmers. The team considers transgenic castor as the project of highest priority.

4.7.2 Sorghum

Sorghum is primarily grown as a rain fed crop in Andhra Pradesh with low inputs. Hence it is an important crop in drought prone regions. Since stem borer, grain mould and drought in rabi are serious constraints to production, the APNLBP has supported three research projects involving three research institutions. The progress of the project at CRIDA was judged to be excellent. Putative transgenic lines of sorghum have been developed for over-expression of mtlD for biosynthesis of mannitol, p5csf129A for proline and codA for glycine betain. The results on sorghum, as presented at NRCS require developing more transgenic lines and obtaining molecular evidence. At CRIDA, the results in case of codA expression were based on Western and p5csf129A were based on tolerance on PEG stress under in vitro conditions. The team expects improvement in results on Southern hybridization. The team suggested that they establish transgenic events by Southerns and gene expression by RT-PCR or Northerns with highest priority.

The generations should be advanced rapidly to establish single copy, homozygous events unambiguously and then pot experiments should be undertaken to assess water stress tolerance. A higher emphasis should be laid on Agrobacterium mediated transformation. They must make their best efforts to obtain such lines by the end of the 2006. New antifungal proteins have been identified under the project at Osmania University. These are: antifungal chitinase from Bacillus subtilis and a synthetic chimeric defensins. The genes have been cloned but have not yet been transformed into sorghum. The review team assesses the progress at OU as promising, and suggest that the novel genes should be taken up for patenting and introduced into sorghum with priority. The progress in generating evidence for gene integration and expression is very important to establish the transgenic nature of the claimed lines. It is desirable to express the stress related genes using stress specific promoters. Cloning such native or heterologous promoters should also be initiated with priority. Finally the lead institute should undertake stress evaluation of all promising transgenic lines at one place and initiate bio-safety studies in the third phase of the programme.

4.7.3 Groundnut

Groundnut is an important oilseed and food legume of the region. Water stress, insects, late leaf spot and tikka disease are four important constraints to yield. The APNLBP has been supporting three projects involving three institutions. At the University of Hyderabad, transgenic lines of an elite cultivar JL 24 have been produced, containing a combination of two genes: rice chitinase and osmotin, npr1 and defensin, and osmotin plus AFP against fungal pathogens. The osmotin gene may also function against drought. The review team emphasizes the need to establish 20 to 30 independently transformed single copy homozygous transgenic lines and obtain molecular as well as phenotypic evidence. Priority should be given to the cases where native plant genes have been used, for instance – chitinase, npr1 and osmotin. Achieving sufficiently high, stable and regulated level of expression will require the use of specialized promoters and screening multiple transgenic events. The review team suggest consolidation of efforts so that the desired objectives can be achieved by the end of 2006. The team was appreciative of the progress especially because the genes were cloned indigenously and advise scientists to look into the issues related to securing IPR.

The project at Sri Krishnadevaraya University has led to the cloning of 1044 ESTs that are differentially expressed in drought-stressed groundnuts. These were sequenced and deposited at the NCBI database. At ANGRAU about three hundred groundnut germplasm lines were screened for water use efficiency and high temperature tolerance. Five superior lines were used as males to cross with seven locally adapted lines as females. A total of 62 crosses were made which have been advanced to F7 generation. In the F6 generation, four uniform selections were made. These possess high SCMR coupled with high yield. The project has made good progress and should be continued.

4.7.4 Pigeonpea

Progress of the project on the development of transgenic pigeonpea with rice chitinase gene is promising. Four T3 pigeonpea lines have been validated by RT-PCR. The review team suggests that at least 20 independent transgenic lines with single copy be produced to overcome possible undesirable effects related to the site of integration. Complete molecular evidence and data on Fusarium wilt resistance following controlled inoculation should become available by 2007 for these lines. If sufficient resistance is noticed at that stage, the material should be taken up for seed multiplication and biosafety tests. In case the level of resistance is not significant or sufficient, alternate genes or stacking of multiple genes should be considered. This would merit extension of the project into a third phase.

The second project aims at the identification of native genes from pigeonpea that are expressed at higher level, following exposure to PEG and water stress. About 600 differentially expressed cDNAs have been sequenced. The team suggests prioritization of experiments with an aim to validate functional utility of two to three expressed sequences in the next two years. This requires reverse Northerns with the most contrasting differentials, full length cloning of the most promising two to three genes and then the transformation of pigeonpea. Such genes are expected to function incrementally and may have to be expressed from stress specific promoters. The project is important to identify novel genes. The centre needs to enhance efforts and focus so that convincingly useful experimental transgenic lines become available by 2007. The work may then be expanded in the third phase when higher level of support will be needed.

ICRISAT staff has identified some wild species of Cajanas for resistance to Helicoverpa. A programme on wide hybridizations to introgress such genes into pigeonpea has been initiated. The project is promising though it will take several back crosses before the problems related to the level of resistance and linkage drag are overcome. The project will show its logical achievements in the third phase.

4.7.5 Molecular Markers

The project at ANGRAU aims at breeding castor lines for resistance to Fusarium wilt and Botryits grey rot. Germplasm was screened by pot culture for resistance to three pure cultures of Fusarium oxysporum ricini. Resistant lines were identified and are being used in back crosses and selfing of F1 to derive mapping populations for molecular mapping. Since Botrytis resistant germplasm is not known in castor, gamma irradiation and EMS mutagenesis were used to induce variability for the trait. The mutated stocks have been selfed for two generations. Screening under field conditions will be undertaken in M2 so that recessive genes for resistance can also be identified. The review team feels that progress is excellent. The Fusarium work is more promising since resistant germplasm is available. The efforts to develop molecular maps and tag the genes for resistance with molecular markers should continue. Due to the nature of work, a long term and higher level of support should be provided for this component in the third phase of the project.

4.8. Tissue culture for rapid multiplication of elite planting material

The technologies for micropropagation of neem and teak were developed at CRIDA under the project and transferred to NGOs in different districts for scale up and distribution of elite clonally propagated plants. An ecotype of neem selected for high ‘azadirachtin’ through five years was multiplied. The micro propagated trees are expected to establish faster and give 25-30% higher fruit yield and ‘azadirachtin’ at several locations covering more than 350 acres land area. In the case of teak the micropropagated plants are expected to give 15-20% higher yields of wood. The KVKs in Mahaboobnagar and Nalgonda districts have established rural tissue culture laboratories and have produced around 80,000 and 10,000 plants respectively. They have sensitized the end users on the merits of using tissue culture plants and have trained them in the identification of elite plants, glass house activities and field evaluation. The review team noticed uniform growth of micropropagated trees as compared to the stumps in a 16ha farm trial in Gaddipally village. The project has provided elite planting materials, catalyzed enthusiasm for agro-sylvi horticulture and has demonstrated the feasibility of rural tissue culture units for holistic development of farms, animals, ecosystems and high economic returns.

Methods for mass propagation of custard apple (Annona squamosa), tamarind (Tamarindus indica), amla (Emblica offcinalis) and karaya (Sterculia urens) have also been developed. These include efficient applications of methods like micropropagation, grafting, budding and rooted cuttings as appropriate, and training farmers on the identification of elite planting materials, sensitizing them to adopt improved technologies like seedling treatment, pot mixtures, nutrient and disease management. The project has trained village communities to appreciate and participate in the knowledge chain of the research laboratories, the NGOs, KVKs and farmers. The review team appreciates the community acceptance that has emerged from these scientific approaches.

4.9 Livestock management for enhancing livelihood security

For livestock improvement, income enhancement and employment generation several interventions have been made though initiatives taken by APNLBP. Fifty two cross bred cows between locally adapted breeds and Jersey cows as well as high milk producing Murrah buffaloes were introduced in the project area. The original programme was in four villages but the diffusion is spreading to other villages. Cross bred cows produce four times more milk as compared to native cows. Since there is a shortage of fodder, green fodder development has been undertaken by introducing Napier grass – bajra hybrids which produce higher biomass and several cuttings can be made from ratoons. Chaff cutters have been introduced into several villages for producing chaff of uniformly small pieces for better utilization of fodder by cows and buffaloes. 750 chaff cutters have now been purchased by villagers in this project area. Machines for extrusion of crop residues such as cotton and castor stems have been introduced which pulverize the residue into small pieces. By adding concentrates into the pulverized materials pellets are made for animal feed. Another intervention is the addition of yeast culture to improve the utilization and digestibility of extruded materials. Technology for production of dried yeast culture at village level has been successfully introduced. Urea treatment of rice straw improves its digestibility and palatability. Para workers have been trained for artificial insemination of cows and buffaloes. They have been provided with insemination kits, each costing Rs.10,000/-, by APNLBP.

Local sheep and goat herds have become highly inbred resulting in poor health, low birth weight and high mortality of lambs. To alleviate this problem rams from unrelated herds have been introduced to increase genetic diversity. This has resulted in healthier lambs with 3-4 kg birth weight as compared to only one kg of birth weight of lambs of inbred herds. Lambs from improved herds are disease resistant and grow faster. In the improved herds one ram serves 18 sheep as compared to 30 sheep in the inbred herds. Sheep pox cell culture vaccine has been produced at the Veterinary Biological Research Institute and 21.63 lakh doses of vaccine have been supplied to shepherds at the cost of Rs1.00 per dose. Vaccination is done for treatment of Blue Tongue disease of sheep. Poultry production has been improved through introduction of better poultry breed, Vanaraja. The introduced breed lays bigger eggs, chicks grow faster and attain a body weight of 3-4 kg as compared to 1-2 kg for local breeds. About 10,600 Vanaraja poultry birds have been provided to women farmers to improve their health status and income. Poultry birds are regularly inoculated against ranikhet disease.

4.10 Medicinal plants for family health

Four projects on medicinal plants are being undertaken primarily to enhance awareness for this traditional system of medicine and provide affordable alternatives to poor communities for primary health care. Over 200 training programmes have been organised in villages and nurseries have been set up to provide planting materials. The overall guiding principle has been to encourage women to grow medicinally important plants in their kitchen gardens and manage common ailments. The effort is valuable for the impoverished villagers since modern medicines are often not available. The review particularly found women very enthusiastic who reported beneficial effects of Aloe barbadensis in gynaecological problems and Withania somnifera for general well being.

The evaluation team emphasises the need to collect systematic data on the ailments for which specific plants have been found effective. The data should explore possible relationships of disease response with the type of plant used or its part and gender, age, food habits etc. There is a need to collect wider germplasm of a given plant species and to standardise the formulations through systematic phytochemical analysis. A larger sustainable model will require using improved cultivars and developing rural extraction and distillation units based on harvests from 5 to 10 hectare land area to make it remunerative for a cooperative of farmers within a biovillage.

5 Human Resource Development (HRD)

5.1 University Programmes

It may be seen from Table 3 that HRD in biotechnology has received 14% of total allocations made so far. Support has been given to MSc biotechnology programmes at Acharya N G Ranga Agricultural University (ANGRAU) and Sri Krishnadevaraya University (SKU), Anantapur. Also refresher courses for in-service teachers and researchers were the direct initiative of the programme to contribute to quality education in biotechnology and to create skilled manpower. Up till now through 13 refresher courses, 192 teachers and researchers all over the State have been trained to impart better education. About 92 students have benefited from the MSc Programmes.

Besides these direct interventions the Programme has also supported six persons for their overseas training ranging from 15 days to 30 days. They were trained in the Netherlands, Switzerland and China. Few scientists were also sponsored for participation in the international conferences. Further 213 young scientists were employed in the research projects and were trained in different techniques. Out of them, 29 received PhDs from the work they did in the projects. It is heartening to note that as many as 42% scientists were women.

In terms of qualitative contribution the programme helped in improving the competitive spirit among scientists, enhancing their commitment for participatory research, producing socially relevant technologies and motivation to do better for the benefit of society at large. This is reflected in some of the awards received by the researchers. For example one of the women scientists was awarded the Best Woman Scientist Award for the year 2004 by ICAR. Another PhD thesis by a woman candidate was adjudged as the best thesis. In both the cases the work was done under the projects supported by APNLBP. With a view to encourage young scientists to pursue PhD Programme, the Programme instituted all together 10 PhD fellowships beginning from 2004-2005. Last year four candidates (3 in life sciences, 1 in social sciences) were awarded fellowships for a period of three years. The researchers in life sciences have already started their work while the student in social sciences is yet to start her work.

5.2 Networking and Learning

The Programme has spent considerable time in sharing experiences of and learning from other programmes. The staff of the secretariat, members of the BPC and the principle investigators of projects have all participated in different fora to share experience. More particularly BTU staff have been involved in a number of training programmes and workshops organized by premier institutions like the National Institute of Rural Development (NIRD), the National Academy of Agricultural Research Management (NAARM), the National Institute of Agricultural Extension Management (MANAGE) and the M S Swaminathan Research Foundation (MSSRF), Centre for Economic and Social Studies (CESS). Participants from different parts of the country and the Asia and Pacific region benefited from these interactions. Recognizing the expertise available in the Programme, the Programme Co-ordinator has been invited by the Ministry of Agriculture, Government of India to be a Member of Research Advisory Committee and Institute Management Committee of NAARM. The Programme also provided inputs into the preparation of an international programme on "Climate Change" jointly prepared by Swiss Development Cooperation, MSSRF, Action for Food Production (AFPRO) and MANAGE. It has rendered services in evaluating some of the research projects funded by NATP and has contributed to discussions on its next phase of the National Agricultural Technology Programme. In addition experiences have contributed to other programmes and into policy making more generally both at national and regional level through its Chairman who is also a member of a number of advisory committees at State and National level.

A significant contribution of this experience sharing has been the creation of an international *Tailor Made Biotechnology* (TMBT) network under the leadership of the Technology and Agrarian Development Group of the Wageningen Agricultural University, Research, Wageningen in the Netherlands. As a founder member of this network, the Programme interacts with other partners from Brazil, Cuba, Ghana, Kenya and the Netherlands. The Programme also offered its experiences to the Programme on "Molecular Breeding for Pest and Disease Resistance" sponsored by Asian Development Bank and hosted by ICRISAT. It also collaborated with South Asia Biosafety Programme (SABP) supported by IFPRI and Ag. Bios and ICRISAT in organizing a trainers training programme on agricultural biotechnology for a multi-stakeholder group.

As a part of experience-sharing the programme is offering courses for students of MSc and PG Diploma (MBA) at Acharya N G Ranga Agricultural University (ANGRAU) and the Institute of Public Enterprise (IPE) respectively. It is also the firm belief of the programme that the combined effect would be much higher if it collaborates with other developmental programmes. Towards this, it organized a number of meetings with other developmental agencies which resulted in alliances with new partners. Collaborations with NIRD, transfer of technical know-how by some of the partners to Andhra Pradesh Irrigation Project, sponsored by FAO and the Netherlands, ongoing discussions with Winrock International are only a few examples of our efforts towards convergence.

5.3 Capacity Building

Capacity building can be seen both in quantitative and qualitative terms. In quantitative terms, participating research organizations have been strengthened with state-of-the-art of infrastructure including equipment. This critical support has stimulated them to modernize their laboratories and create additional infrastructural facilities with their own funds. In some cases separate departments have been set up to intensify research and training in biotechnology. It is estimated that out of the total funds made available by the programme as much as 35% has been spent only on equipment. The other form of capacity building has been supporting partners with human resources. The cost of manpower both in the laboratories and in the field for extension work was met by the Programme. These personnel were also trained in research experiments and frontline demonstrations. It is estimated that overall around 213 persons have been employed directly in projects as researchers and technicians. The share of manpower expenditure has amounted to 22% of total allocations made. In this way project staff who work in research projects have gained experience under the supervision of the project leader and through seminars, workshops and short-term training courses. Many of them have also simultaneously pursued PhD and post doctoral certificates. An important contribution of the Programme has been to enhance the sensitivity among these young researchers towards societal relevance of the technologies with which they are working.

Besides sharing the experiences, the Programme also learns from other experiences. As a part of this, the members of BTU undergo training, participate in workshops and conferences organized by national and international organizations. For instance, two of the staff members were trained at International Agriculture Centre in Wageningen on plant breeding, biotechnology and biosafety. One of the staff members was trained on biotechnology and public awareness at Oxford in U.K. The Co-ordinator and one of the staff members were trained on management aspects of biotechnology by ISNAR and Management Development Foundation, the Netherlands respectively. The Subject Experts of BTU also underwent advanced training programmes on PTD.

5.4 South-South, South-North Collaborations

Linkages have been established with other country programmes supported by the Netherlands viz. Columbia, Kenya and Zimbabwe. APNLBP took the initiative to organise the first meeting of the four country programme chairpersons and co-ordinators along with programme officers responsible for these programmes within DGIS. Such meetings were then repeated by other programmes in Kenya, Zimbabwe and Columbia. It enabled training of researchers from Kenya on tissue culture. It organized an international workshop on Biosafety and IPR involving participants from Zimbabwe and Kenya, and was represented in corresponding workshops in Zimbabwe and Kenya. Besides these direct personal contacts, the programme stays connected with others through information exchange. In the recent past the Programme also established rapport with scientists in Malaysia which it would like to utilize in future.

As regards South-North collaboration, in a relatively short period the programme has established working relations with Maastricht University, Erasmus University and Wageningen University in the Netherlands. Four MSc students from these universities spent four to five months at APNLBP and did their internship as part of their Master's Degree. An Associate Professor from the Department of Technology and Agrarian Development of Wageningen University also spent about two weeks documenting case studies of tailor-made biotechnologies emerged from APNLBP. As a continuation of these linkages the programme is also discussing possibilities of setting up a sandwich PhD programme with WUR, Wageningen under its Interdisciplinary Research and Education Fund Programme (INREF). In the same spirit preliminary discussions were held with a visiting delegation from California University, Davis, USA.

Overall it must be said that HRD has been a major strength of the programme, not so much in the formal academic sense (though that has been good) but rather in those qualitative senses that have become so important to its effectiveness as an innovative venture. Special mention must be made of the steps taken to empower women, build up capacities of BTU staff, develop effective networking arrangements, encourage skill development in rural areas, mobilise and strengthen the participant NGOs, and generally broadening the capacities of all elements of the programme as a whole. That having been said there are still HRD weaknesses in certain areas that will require more effort and resources in the years to come. The team will return to this point below.

6 Governance

6.1 Present Institutional Structure

The institutional structure of the programme is as follows. Broadly it consists of BPC, MOFA, Government of the Netherlands, Biotechnology Unit of IPE, implementing organizations and end users. Ownership is entrusted to a multi-stakeholder steering committee called the Biotechnology Programme Committee (BPC). The Committee consists of representatives from grassroot level NGOs, heads of developmental departments of the State Government, representatives of the Department of Biotechnology (DBT) and the Indian Council of Agricultural Research (ICAR), Government of India (GOI) and scientists of national and international repute. Out of 14 members 3 are women. The Committee is headed by Dr M V Rao, a renowned agricultural scientist. The Committee operates within a set of rules and regulations formulated by itself. One of the important features of these rules and regulations is that any member who abstains from three consecutive meetings disqualifies himself or herself from membership. The Committee met 42 times in ten years during the period from 15th July 1995 to 16th July 2005 i.e. on an average 4.2 times per year. The commitment of the members is evident from the fact that the average attendance of members was 83%.

The Committee is supported by a Secretariat, the Biotechnology Unit (BTU), hosted by the Institute of Public Enterprise (IPE). The institute is an autonomous society engaged in teaching, research, consultancy and training in the field of public enterprise management and public policy. It has core funding from the Government of India and the Government of Andhra Pradesh. The BTU team consists of a multidisciplinary group with a Co-ordinator, four subject experts and four supporting staff. The main functions of the Secretariat are to assist the BPC in ensuring that the objectives and approach of the programme are followed; that project proposals follow the established criteria, and that end user participation and feedback is handled appropriately.

Within the broad priorities identified, research projects are formulated on the basis of specific problems based on farmer demand. Problems are identified and prioritized based on the severity of the problem, urgency to address it and the potential of biotechnology to solve the problem. The programme uses a Pre-Project Formulation Workshop (PPFW) to arrive at consensus on these issues. Different stakeholders including scientists, extensionists, NGOs, farmers etc., are invited for these workshops. Also invited are experts at national and regional level who explain the status of the crop, the production constraints, the state of art of technology and the possible interventions, including the biotechnological interventions. Farmers in their own language explain their experiences and articulate their needs. Different stakeholders then resolve to work together to seek solutions through biotechnology. Such a resolve takes the form of a project proposal that undergoes peer evaluation before coming to the BPC for a final decision. Once the decision is taken to fund a project a strict monitoring mechanism is put into operation.

The programme appears to maintain good cooperation and coordination with the Ministry of Foreign Affairs, Government of the Netherlands. A representative of the Government of the Netherlands visits at least once a year for meetings with the IPE and the APNLBP. Besides discussing programme progress these occasions are also used for interaction with different stakeholders in the field and visits to laboratories. Apart from these annual visits the programme has also been visited by the officer in charge of the research division of DGIS in 1997, the Chief Scientist, Ministry of Foreign Affairs, Government of the Netherlands in 1998, the Chief of the Research Division in 2003 and the Ambassador of the Netherlands to India in 2005. These visits reflect the keen interest of the donors in the programme. At the same time

DGIS has maintained a "hands-off" policy right from its inception in 1995, a factor that clearly indicates confidence in the programme's management.

Overall the programme's governance structure has worked reasonably well. However, the team will argue below that the time has come for it to "change gear" as a result of its undoubted success over the past ten years. To fulfil its potential will require a broader funding base, a revised legal status, considerable improvements in numbers, skills and quality of manpower, and the managerial capacity to move on to new levels of function.

6.2 Financial Matters

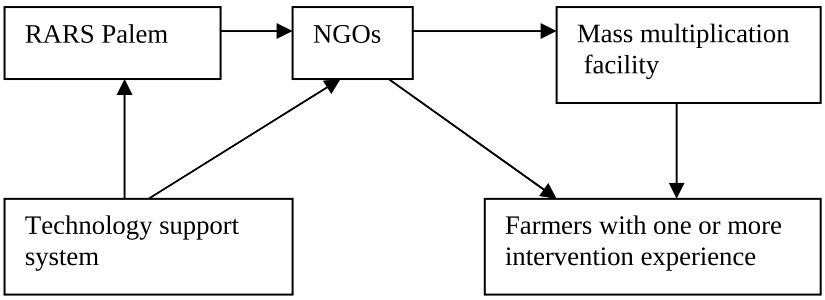
The funds received from the DGIS are kept in Andhra Bank, Vidyanagar Branch, Hyderabad. For the purpose of convenience the funds are kept in two accounts – the main account and the projects account. The main account has small amounts for meeting day-to-day operational expenditure. Major funds are kept in projects account from where expenditures are disbursed to the project implementing agencies. Taking into account monthly requirements, funds not to be disbursed are kept in fixed deposits for periods that range from three to six months. Interest accrued is spent on the Programme according to the same conditions stipulated for the purpose of implementing the Programme. The accounts are jointly operated by the Co-ordinator of BTU and the Director of IPE. The Co-ordinator is authorized to operate accounts up to a maximum amount of Rs.20,000/- with a single signature. Any cheque exceeding this amount requires the signatures of both the Co-ordinator and the Director of IPE. While the operational part rests with the Co-ordinator and the Director actual decision-making for disbursements to the projects rests with the Chairman of the BPC. His decision is based on the approved work plan and the budget.

The agreement between the Dutch MOFA and IPE states that BTU expenditure should not exceed 20% of Programme expenses. In fact currently this figure stands at around 17%, which includes a 50% administrative charge on salaries and a 15% rental paid to the IPE, an amount that strikes the evaluation team as somewhat excessive. However, the evaluation team notes that BTU expenditure overall is a good deal lower than is common in many comparable bodies. Accounts are audited by a qualified chartered accountant, who happens also to be the Auditor of IPE. The accounts are computerized and auditing was brought up to date as of 31st March, 2005. Audit statements have been forwarded to the DGIS every year within the stipulated period. Details of programme expenditures may be seen from Tables 1 – 4 in the Appendix. The evaluation team believes that financial management of the programmes is handled in a satisfactory manner.

6.3 Organization of outreach activities:

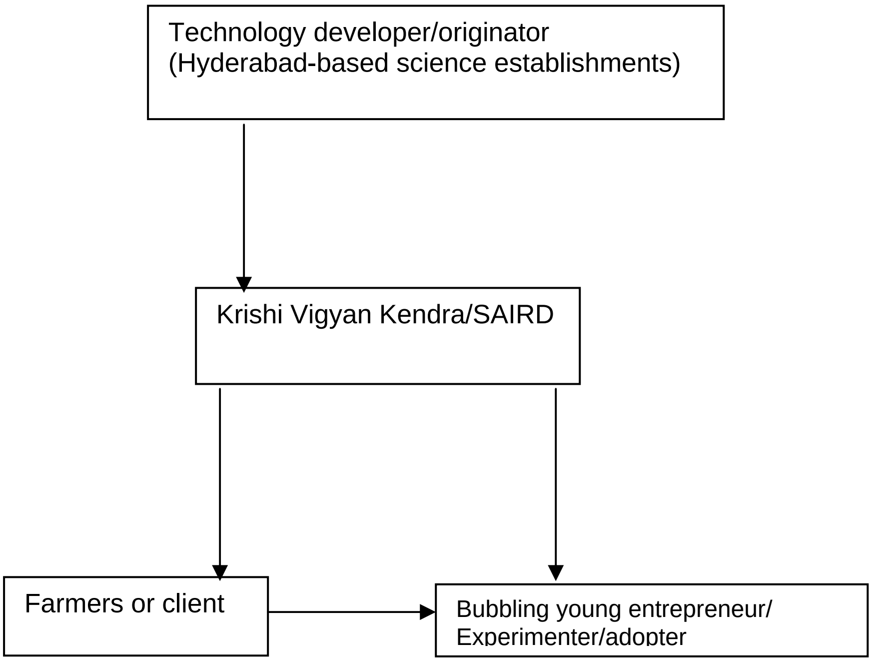
While the hub of the APNLBP is the BTU which is housed in the IPE and serves as the integrator of activities, the programme as a whole is actually a complex network consisting of many groups and projects for the generation of new knowledge and discovering genes that have long-term implications in addressing crop production problems of the dry land areas. Thus there are biological software activities like biocontrol systems, tissue culture for micro propagation, and on-the-ground programmes involving farmers in activities such as agro-silvi-horti pastoral systems, vermiculture, mushroom cultivation, agricultural machines for making feed, expellers and shellers. Technology delivery is through NGOs who help to promote micro entrepreneurships in various areas. The APNLBP seems to have adopted two approaches to technology delivery. These are:

Model 1



Here the regional research centre at Palem, Mahaboobnagar serves as the local science centre with backdrop research scientists and research-product development linkages with other research establishments at Hyderabad. The NGOs who interact with knowledge sources develop the validated relevant technology either by scaling up the production facility with them (as with the Bt multiplication facility, biofertilizer and spawn production) or by involving farm families for testing and adopting each component of the technology or a group of them. However, a holistic approach to promote diversified farming systems for livelihood security did not appear to be on their agenda, although possibly covered by them in the same village from funding sources other than the APNLBP. The NGOs on completion of the APNLBP are likely to continue activities further as they have mass production facilities with them in a revolving fund mode.

Model 2



The other model, followed in Nalgonda, has similar elements as Model 1, except that in the institutionalized KVK model facilities for mass production of biofertilizer, vermicomposting, biocontrol agent, tissue culture of trees and micro propagation of planting materials, are housed with well-developed class room and trainee facilities. It revolves around extramural scientists and KVK staff with agricultural science backing. They have promoted young entrepreneurs in all the sectors in which they are operating. The village level extension activities even in agroforestry, silvipastural system, cattle breeding all in a holistic manner are covered by the KVK and the SAIRD system. The activity here driven by KVK and SAIRD is addressing rural livelihood issues perhaps in a more integrated manner compared to the Model-1. Both models have their strong and weak points but it is suggested that a project to assess the functioning and success of these two models may be undertaken, perhaps as PhD projects by social science students.

7 Recommendations

This final section outlines the main recommendations of the evaluation team. The team takes a positive view of the APNLBP as a whole. It has made considerable progress since the time of the 2001 review report particularly in basic research, technology development, capacity building and technology transfer. Even more important are the qualitative outputs like the process of participatory technology development, the networking of different organisations (often for the first time), building capacities of local people to articulate their needs for the development of technologies, and the building of institutional and individual commitments to needs-based technologies. On this basis the team believes that the programme should be extended for a third phase of 5 years. However, its very success also means that certain issues now appear that may require a new governance structure. Effectively the programme has evolved into (and now represents) a new and highly innovative institutional "model" of agricultural development—a new "research paradigm" as one stakeholder stressed. But in order to fulfil its promise on a wider canvas certain capacities will need to be built. These would certainly include the following:

1. Establishing the capacity to spread technologies to farmers beyond the current village areas. This will involve the creation of more rural units of the kinds established at Palem and Gaddipally. The team believes that such units should henceforth act as the hub of technology development activity. They would act as "knowledge centres" integrating the various activities such as central research and NGO extension work to bring about a greater coherence to the programme as a whole.
2. Broadening the economic base of rural interventions through establishing wider technology packages. Of course this will require further "needs assessment" work but the team has the impression that particular attention should be given to improvements in nutrition and the quality of herbal medicines. Relatedly perhaps a greater focus on the establishment of kitchen gardens and vegetable growing could be made.
3. Acting as a forum to improve connectivity between the many research bodies that are involved. Although this is certainly a stated component of APNL policy the team believes that there are too many examples of different projects not connecting with one another with the result that synergies have been lost. The establishment, for example, of regular cross-organisational seminars on transgenics would be one mechanism that might help in this regard.
4. Developing a new form of programme coherence for Phase 3. Perhaps the time has come to cut down on the sheer spread of research project areas and to concentrate now on those that show greatest promise for the future. Similarly where a number of separate institutes have been working in similar areas in Phase 2, in Phase 3 such research should take place only in that organization where most success has been achieved.
5. Building the entrepreneurial, marketing and related capacities of farmers and local production centres to access larger markets that will enable activities to be commercially sustainable in the long run. One important potential mechanism here could be investigating the establishment of partnerships with industry and advising stakeholders about future sustainable models that could be pursued in this context. This may be particularly appropriate in the cases of oil seeds, transgenics, biofertilisers and biopesticides.

6. Developing more accurate objective knowledge on the actual socio-economic impact of the programme, through detailed *ex post* assessment studies. This is especially pertinent to the production of biofertilisers and biocontrol agents where emphasis should shift from research activity to economic development potential of small scale units in rural areas.
7. Building up business development knowledge in organisations. This will include importantly how to handle IPR issues where the team detected significant weaknesses. For example, there were many examples where projects had clearly reached the stage where relevant IP protection could have been sought. But in only one case had this actually happened. Additionally there were no cases where IP parameters had been sought out at project proposal stages. As an interim measure it is suggested that all successful proposals should be required to incorporate an IP plan before funding begins.
8. Ensuring that the lessons of the APNLBP are adequately documented so that the model may be efficiently communicated to a wider public. This would include producing accessible training and educational materials that may be distributed to poor families and schoolchildren. In addition the APNLBP model should have applicability in many other developing countries. The programme is therefore encouraged to make some efforts in this direction also.
9. Accessing alternative and additional sources of funding so that it will be possible to capitalise on the programme's successes such that new aspirations can be adequately resourced. This is especially important from the viewpoint of increasing the number and quality of skilled manpower that will certainly be needed. The programme is encouraged to tap into the local banking sector for venture capital and other forms of development finance
10. Ensuring that the programme comes to the attention of leading political authorities
11. The team's emphasis on bio-control and bio-fertilizer agents should not be misinterpreted as showing that both chemical fertilizers and pesticides can be dispensed with completely. While some may do so, prudence demands that to ensure a good income when pest threshold levels are high farmers may still resort to chemical pesticide uses as a last resort.
12. Since genomic studies on the Dryland crops are not of major interest to private enterprise and of lower priority in current international programmes, it will timely if a higher level of sustained support is provided to such studies under the APNL programme during Phase 3

8 Future Strategy

In the team's view it is unlikely that the programme's existing institutional setting will give it the necessary scope and flexibility to carry out these and related functions. Indeed international experience indicates that when a programme has evolved as far as the APNLBP has done and has therefore moved on to a new level of activity, it will require correspondingly new institutional arrangements to permit it to fulfil its aspirations and potential. It is therefore recommended that as soon as is practicable the programme becomes an autonomous unit with a revised legal status and a location appropriate to its new needs. This should enable it to access more easily the greater level of resources (especially with respect to manpower) that will be necessary to take its programme on to the new levels anticipated. The exact form this new structure should take is a matter for the BPC of course although there are a range of possibilities to choose from. The important point is to ensure the necessary autonomy for the governance of the programme as a whole. Early consideration of this matter would permit the programme to use DGIS funding also as a means of institutional change. More specifically the programme in Phase 3 might be given a title that reflects its new and enlarged role. Whatever its title the new body would have the following functions:

- To act as a promotional and applications agency of all biotechnological knowledge and products related to agriculture, animal husbandry and rural development for increasing rural incomes, environment, health and living standards of poor farmers in a sustainable manner.
- To protect the intellectual property rights of inventions, cover interests under “Geographic Indications” stipulations and genetic material assets of farmers, facilitate the transfer of innovations for product development to enterprises through appropriate agreements and sale deeds, and operate any gene fund that may accrue.
- To raise corporate and other funds from diverse sources, including royalties on products, and to run appropriate programmes to achieve its objectives.
- To promote proper communications within communities for the use of their biological resources in a manner that promotes gainful employment of the rural people and enhances their livelihood security without endangering fragile rural ecosystems.

Such a body would continue to have its own board of management and functional rules although the board’s composition and structure might be revised appropriately in the light of its new needs. It should be located at a suitable centre with a clear mandate to interact with any institutions located both within Andhra Pradesh and in the rest of the country and overseas to identify and mobilise knowledge, technology, products, human resources and finance with the overall objective of achieving its vision in an effective and efficient manner. Networking will be a critical component of such activities. Phase 3 of the APNLBP would then be in a good position to share its experiences and help in establishing a system that can be emulated by other states of the Indian Union and by other developing countries.

Appendix

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2. Abbreviations

AFPRO	Action for Food Production
ANGRAU	Acharya N G Ranga Agricultural University
APNLBP	Andhra Pradesh Netherlands Biotechnology Programme
BPC	Biotechnology Programme Committee
BTU	Biotechnology Unit
CESS	Centre for Economic and Social Studies
CFTRI	Central Food and Technological Research Institute
CGIAR	Consultative Group for International Agricultural Research
CRIDA	Central Research Institute for Dry land Agriculture
CSIR	Council for Scientific and Industrial Research
DBT	Department of Biotechnology

DGIS	Directorate General for International Cooperation
DOR	Directorate of Oilseeds Research
FAO	Food and Agriculture Organization
GOI	Government of India
HRD	Human Resource Development
IBU	Interactive Bottom Up approach
ICAR	Indian Council of Agricultural Research
ICMR	Indian Council of Medical Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
IFPRI	International Food Policy Research Institute
IICT	Indian Institute of Chemical Technology
INREF	Interdisciplinary Research and Education Fund Programme
IPE	Institute of Public Enterprise
IPM	Integrated Pest Management
ISNAR	International Service for National Agricultural Research
KVK	Krishi Vignan Kendra
MANAGE	National Academy of Agricultural Research Management
MAS	Marker Aided Selection
MOFA	Ministry of Foreign Affairs, Government of the Netherlands
MSSRF	M S Swaminathan Research Foundation
NAARM	National Academy of Agricultural Research Management
NATP	National Agricultural Technology Project
NBPGR	National Bureau for Plant Genetic Resources
NBRI	National Botanical Research Institute
NCBI	National Centre for Biotechnology Information
NEDA	Netherlands Development Assistance
NGO	Non Governmental Organization
NIN	National Institute of Nutrition
NIRD	National Institute of Rural Development
NRCG	National Research Centre for Groundnut
NRCPB	National Research Centre for Plant Biotechnology
NRCS	National Research Centre for Sorghum
PPFW	Pre Project Formulation Workshop
PSB	Phosphate Solubilising Bacteria
PCR	Polymerase Chain Reaction
PTD	Participatory Technology Development
RTP	Rural Technology Park
SABP	South Asia Biosafety Programme
SKU	Sri Krishnadevaraya University
TMBT	Tailor Made Biotechnology
UAS	University of Agricultural Sciences

UNDP	United Nation Development Programme
WUR	Wageningen University Research, The Netherlands

3. Programme Schedule of the Evaluation Team

Day & Date	Time	Details of visit
3rd October Monday	1000 – 1300 hrs 1300 – 1400 hrs	BTU - Chairman - Co-ordinator - Presentation by BTU staff and photo exhibition Lunch
	1430 – 1530 hrs 1530 – 1700 hrs 1900 – 2100 hrs	IPE - Meeting Director - Visit to IPE facilities - Planning the evaluation - Listing information requirements - Discussing checklist - Dinner with BPC & BTU staff
4th October Tuesday	1100 – 1300 hrs 1300 – 1400 hrs 1400 – 1600 hrs 1600 hrs	**Visit to Directorate of Oilseeds Research (DOR)** - Castor Bt, castor transgenic and wilt Lunch **Visit to National Research Centre for Sorghum (NRCS)** - Sorghum projects Departure to Palem (Night stay at Palem)
5th October Wednesday	0930 – 1600 hrs 1600 hrs	Visit to Society for Development of Drought Prone Area (SDDPA) Fields visits + interactions with other NGOs of Mahaboobnagar Departure to Hyderabad
6th October Thursday	1000 – 1300 hrs 1300 – 1430 hrs 1430 – 1600 hrs	**Visit to Central Research Institute for Dry land Agriculture (CRIDA), Santoshnagar, Hyderabad** Tissue culture, biointensive pest management, sorghum abiotic stress management and agroforestry Lunch **Visit to Centre for Plant Molecular Biology (CPMB), O U** **Campus, Hyderabad** - Transgenic sorghum, castor, pigeon pea, tissue culture, abiotic stress management and refresher course
7th October Friday	1000 – 1300 hrs	**Visit to Acharya N G Ranga Agricultural University (ANGRAU)** - Groundnut (Dr P V Reddy) / Yeast Culture (Dr G Narsa Reddy) /MSc (Dr S Sivarama Krishna) / Castor (Dr P Jenila)/Mushroom (Dr Sudhakar) / IPM (Dr M V Reddy)/ Diagnostic kits (Dr D Sreenivasulu) / Nematodes (Dr Sudheer) plus other PIs.

	1300 – 1400 hrs 1400 – 1530 hrs 1600 hrs	Lunch Lab visits + interaction with MSc students Departure to SAIRD (Night stay in Miryalaguda)
8th October Saturday	0930 – 1600 hrs 1600 hrs	**Visit to Sri Aurbindo Institute of Rural Development (SAIRD)** - Field visits + interactions with other NGOs of Nalgonda + Animal Husbandry Department Departure to Hyderabad
9th October Sunday	1000 – 1300 hrs 1300 – 1400 hrs 1430 – 1700 hrs	Stakeholders meeting (NGOs, scientists, resource persons, media reps, private companies, extension institutions, PhD scholars etc.) Lunch Stock taking and planning for the remaining period
10th October Monday	1000 – 1300 hrs 1300 – 1400 hrs 1430 – 1700 hrs 1700 – 1900 hrs	Report writing Lunch Visit to University of Hyderabad (UOH) Visit to ICRISAT followed by dinner
11th October Tuesday		Report writing Dinner with Heads of Research Institutions in Hyderabad
12th October Wednesday		Report writing
13th October Thursday	1000 – 1300 hrs 1300 – 1400 hrs	Report presentation followed by discussion Lunch

4. Financial Details

Table – 1

ANDHRA PRADESH NETHERLANDS BIOTECHNOLOGY PROGRAMME

Subject-wise funds committed and disbursed

(As on 31.7.2005)

(Rs. in lakhs)

Res Area Code	Subject of Project	Funds Committed	Funds Disbursed
A	Agroforestry [1]	105.45 (3.28)	72.64
B	Animal Sciences [8]	294.41 (9.173)	248.16
C	Biocontrol Agents [13]	576.57 (17.97)	416.86
D	Biofertilizers [6]	148.72 (4.63)	140.73
E	Botanical Pesticides [2]	78.63	71.96

		(2.44)	
F	Genetic Engineering [11]	635.17	589.02
		(19.79)	
G	Medicinal Plants [5]	142.35	77.15
		(4.43)	
H	Post Harvest Technology [5]	101.62	80.93
		(3.16)	
I	Tissue Culture [7]	237.93	227.52
		(7.41)	
J	Molecular Marker Assisted Selection [2]	100.00	64.34
		(3.11)	
K	Capacity Building [5]	453.20	389.82
		(14.12)	
L	Bioresource centre [4]	168.11	31.49
		(5.23)	
M	Others [5]	107.41	72.75
		(3.36)	
N	Supportive Activities [7]	59.88	52.98
		(1.86)	
	Total [81]	**3209.45**	**2536.35**

Figures in parenthesis are percentages to total funds committed.

Table – 2

Organization wise commitments and disbursements

Sl No	Organisation	Amount Committed (Rs. lakhs)	Amount Disbursed (Rs. lakhs)	No. of Institutions Involved
1	Government of AP	197.70	146.90	3
2	Universities	1747.15	1412.15	7
3	ICAR	660.18	502.97	5
4	CSIR & ICMR	119.53	94.01	3
5	NGOs	452.59	348.02	19
6	BTU-IPE	32.30	32.30	1
	Total:	**3209.45**	**2536.35**	**38**

Table - 3

Statement of Budget approved and Expenditure
incurred for the period from 1.11.1995 to 31.7.2005

(Rs. In lakhs)

S.No	Particulars	Projects		Programme Management	
		Approved Budget	**Amount Released**	**Approved Budget**	**Expenditure Incurred**
		Rs.	Rs.	Rs.	Rs.
I	**1st Phase:-**				
1	1996 (1.11.1995 to 31.12.1996	0.00	0.00	0.00	17.89
2	1997	391.30	153.64	47.67	28.50
3	1998	396.00	113.16	47.17	32.28
4	1999	455.00	304.42	52.91	29.10
5	2000	404.00	319.61	63.00	50.95
6	2001	373.20	323.62	71.20	54.84
7	2002 (1.1.2002 to 31.3.2002)	109.11	75.63	20.02	10.79
	Total	**2128.61**	**1290.08**	**301.97**	**224.35**
II	**2nd Phase:-**				
8	2002-03	327.33	357.77	80.27	67.30
9	2003-04	666.83	443.48	95.86	65.48
10	2004-05	530.92	410.59	90.45	62.40
11	2005-06 (1.4.2005 to 31.7.2005)	489.97	34.40	101.62	16.99
	Total	**2015.05**	**1246.24**	**368.20**	**212.17**
	Grand Total	**4143.66**	**2536.32**	**670.17**	**(---------)436.52**

5. List of Participants at the Stake Holders Meeting on 9th October 2005

1. Dr Krishna Ashrit, Former Director of Animal Husbandry
2. Mrs K Aruna,P E A C E
3. Ms Chinnamma Thomas, Rural Development Society
4. Shri K Siva Prasad, Unit Head, Action for Food Production (AFPRO)
5. Dr P Sateesh, Kumar, Prabhat Agri Biotech Pvt. Ltd.
6. Dr K Vijaya, All India Radio
7. Ms B V Mahalakshmi, Financial Express Newspaper

8. Ms Ranta, Stony Carter Consultancy
9. Dr M N Reddy, MANAGE
10. Brig. G B Reddy, National Institute of Rural Development
11. Dr Y Gangi Reddy, National Institute of Rural Development
12. Dr Saibhaskar, Action for Food Production
13. Dr P S Reddy
14. Dr Harveer Singh, Directorate of Oilseeds Research
15. Dr T Jyothirmayi , Central Food Technological Research Institute
16. Dr R Vasanthi, National Institute of Nutrition
17. Mr R Vasirajan, Khadi and Village Industry Commission
18. Dr V Vimala, ANGRAU
19. Mr Mahesh Upender, Kakatiya University
20. Mr K Jaya Prakash Narayana
21. Ms T Mrudula,
22. Dr G Anuradha, ANGRAU
23. Dr Y Yogeshwara Rao, Vikkis Agrotech Limited
24. Dr L G Giri Rao, ANGRAU
25. Ms Padma, NABARD
26. Dr D Suhasini, Commission of Horticulture
27. Dr B Krishna Kumari, Indian Institute of Chemical Technology
28. Dr T Vittal Reddy, College of Agriculture, Rajendranagar
29. Dr M V Shantaram, ANGRAU
30. Dr N P Sarma, Directorate of Rice Research
31. Shri P Rajendra Meher, Meher & Associates
32. Dr Mehtab S Bamji, National Institute of Nutrition
33. Dr A A Nambi, M S Swaminathan Research Foundation

6. List of Scientists interacting with Evaluation Team

A. Directorate of Oilseeds Research, Rajendranagar.

- Dr D M Hegde
- Dr M Sujata
- Dr P S Vimala Devi
- Dr M A Raoof
- Dr M Lakshminarayana
- Dr V Dinesh Kumar
- Ms Mehtab Yasmin
- Dr M Shailaja

B. National Research Centre for Sorghum, Rajendranagar

- Dr R Sitharama
- Dr S V Rao
- Dr K B R S Visarada
- Dr M Padmaja
- Dr Indira
- Dr Balakrishna
- Dr M Aruna
- Mr Sai Kishore
- Mr Prajapathi

C. Central Research Institute for Dryland Agriculture.

- Dr B Venkateswarlu
- Dr Y G Prasad
- Dr M Maheswari
- Dr G R Korwar
- Dr M Prabhakar
- Dr M Vanaja
- Dr N Jyothi Lakshmi
- Dr S K Yadav
- Dr P B Kavi Kishore

D ICRISAT

- Dr W Dar
- Dr H C Sharma
- Dr K K Sharma
- Dr D Keating
- Dr Nahini
- Dr Pandey
- Dr Updhyaya

E University Of Hyderabad

- Prof. P B Kirti
- Dr Apparao
- Dr M Srithayam

F ANGRAU

- Dr R Reddy
- Dr Chandraseka Rao
- Dr V Reddy
- Dr B Reddy
- P V Reddy
- Dr S Krishna
- Dr Jenila
- Dr Sudharka
- Dr N Reddy
- Dr K Devi
- Dr A Sultana
- Dr Anuradha
- Dr Srilaxmi
- Dr N Reddy

G Osmania University (CPMB)

- Dr V D Reddy
- Dr K V Rao
- Dr Ulagnathan
- Dr Giri

H IPE

- Prof. R K Mishra
- V Narayana
- Dr g P Reddy
- Dr Janaki Krishna
- Dr M L N Rao
- V A Raju
- Gopi

I BPC

- Dr M V Rao
- Dr C R Bhatia
- Dr V P Gupta
- Dr Sriramulu
- Dr Hegde
- Dr Madhavi
- Dr Jayalakshmi
- Dr C Ramalakshmi
- Stephen Livera
- Ajaykallam

7. NGO and Farmer Details

A. Details of farmers gathering at Tadiparthi village, Mahaboobnagar district on 5th October 2005.

Name of the NGO and address	Chief executive of the NGO attended	Village wise number of farmers attended	
		Tadiparthi	Munnanur
Society for Development of Drought prone Area (SDDPA) D.No. 42-189/1 Vengalarao Nagar Colony Wanaparthy – 509 103 Mahaboobnagar Dist. (AP)	Shri. Stephen Livera Executive Director	20	20
Action Green Health The Catholic Health Association of India PB 2126, Gunrock Enclave , Secunderabad-500 003	Shri. Krishna Murthy Coordinator, Mrs. Jayamma, Health worker		

B. Details of NGOs and farmers attended to an interactive meeting at Nandimallagadda village, Mahaboobnagar district on 5th October 2005.

Name of the NGO and address	Chief executive of the NGO attended	Village wise number of farmers attended	
		Nandimallagadda	
Society for Development of Drought prone Area (SDDPA) D.No. 42-189/1 Vengalarao Nagar Colony Wanaparthy – 509 103 Mahaboobnagar Dist. (AP)	Shri. Stephen Livera Executive Director	30	
		Dokur	Narlonikunta
Villages In Partnership (VIP) 8-5-24, Teachers Colony, Mahabubnagar-509 002 (A.P)	Dr. T. Nagender Swamy, Executive Director	2	3
		Maddur	Dasarapalli
Peddireddi Thimma Reddy Farm Foundation, Flat No.208, Vijaya Towers, H.No.10-2-287/1/A, Shanthinagar, Hyderabad-500 028.	Shri. N Pradeep Kumar Reddy, Director	2	2
		Burgulpalli	Marikal
Indira Priyadarshini Women's Welfare Association, Gowrishankar Colony, Jadcherla-509 301, Mahabubnagar dist. A.P	Mrs. G Govardhani, Chairman	2	3
		Chegireddiganapur	Vishwanathapur
Eco-club, Environmental Protection Organisation, 8-2-15/B/1, Teachers Colony, Mahabubnagar –509 001.	Shri. G Chandra Sekar, Chairman,	2	2
		Linganpalli	Hamsanpalli

Research in Environment Education and Development Society (REEDS), 17-1-386/S/22, S.N. Reddy Nagar, N.S. Road, Champapet (P.O) Hyderabad-60.	Shri. V. Satya Bhupal Reddy, Executive Director,	5	6

C. Details of Government Officials, NGOs, Scientists and farmers attended for an interactive meeting at KVK, Gaddipally, Veterinary Hospital, Gaddipally, Farmers fields at Duphad, Gaddipally and Punugodu villages in Nalgonda Districts on October 8, 2005.

NGO Representatives and Farmers:

Name of the NGO and Address	Chief Executive of the NGO attended	Village wise number of farmers attended
Sri Aurobindo Institute of Rural Development (SAIRD) Krishi Vignam Kendra (ICAR) Gaddipally – 508 201	Dr G Gopal Reddy	Gaddipally - 12, Duphad – 17, Kutubshahpuram – 2, Lingala – 9, Marrikunta – 4 Ponugodu - 1
Peoples Action for Creative Education (PEACE) Near SLNS Degree College Bhongir – 508 116	Mr K Nimmaiah	Choudherpally – 2 Kesaram - 2
Action for Development of Rural Educational Service Society H.No.1-122, Motakondur Yadagirigutta Mandal – 508 286	Mr B Krishna Murthy	Kacharam - 4
PILUPU H.No.1-3-426/6, Opp Krushi I.T.I Bhongir – 508 116	Mr M Janardhan	Thurkapally - 4
Gramina Mahila Mandali Solipet Village Cheekati Mamidi Post – 508 116	Mrs D Vijayalakshmi	Solipet - 4

Principal Investigators and Research Associates

Dr A R Prasad, Senior Scientist, IICT, PI of the project on *Pheromones*
Dr Jyothi, Senior Scientist, IICT, Co PI of the project on *Pheromones*
Mr P Penchala Raju, Research Associate, RARS (ANGRAU), Lam Project on *IPM in Pigeonpea.*
Mr Prathap Reddy, Research Associate, RARS (ANGRAU), Lam Project on *IPM in Pigeonpea.*
Dr P Ranga Reddy, Principal Investigator, SAIRD, Project on *Biofertilizers*
Mr S Narasimha Reddy, Principal Investigator, Project on *Vermicompost*
Mrs Nagabhusanamma, Principal Investigator, Project on *Mushrooms*
Mr M Balakrishna, Production Manager, Project on *Tissue Culture*.
Mrs Lakshmi, Associate, Project on *Medicinal Plants*

Officials of Department of Animal Husbandry

Dr Narasimha Rao, Deputy Director
Dr Ramchander, Assistant Director
Dr Gopi Reddy, Veterinary Doctor
Dr Venkat Reddy, Veterinary Doctor
Dr Venkanna, Veterinary Doctor
3 village voluntary veterinary workers