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**BIOINFORMATICS AND THE FAO/UNDP FARM PROGRAMME
CURRENT STATUS AND DEVELOPMENT OPPORTUNITIES**

Report

1. Background: FARM Asian Biotechnology and Diversity sub-programme

At its inception in 1993 the FARM programme was aimed at sustainable agricultural and rural development in eight countries in Asia, and was "targeted to resource-poor communities and farm households, with an overall objective of improving the conservation, management and utilisation of natural agricultural resources in rainfed low- and up-land farming systems." At launch the programme was designed to run for five years and was seen as an approach to implementing the decisions of UNCED, in particular aspects of Agenda 21. Initially there were seven sub-programmes, with that on Asian Biotechnology and Biodiversity (RAS/93/066) which constitutes the primary area dealt with in this report. The sub-programme on Biotechnology and Biodiversity henceforth referred to as the "sub-programme", was to provide information on new biotechnologies and assess their potential to contribute to natural resource management in Asia. Instrumental in achieving this was the establishment of an Asian Bioinformatics Network which would "link selected research institutions, potential end users of new biotechnologies, with particular relevance to the needs of the resources-poor farmers in rainfed areas". The aim was to disseminate information on relevant technologies and allow processing of the "information into a form suitable for use by extension agents, farmers and researchers"¹.

Additional objectives of the **sub-programme** were:

Immediate

- to establish an Asian Bioinformatics Network involving eight countries to enable exchange of information on biotechnology amongst the member countries
- to undertake technology assessment on the potential of new biotechnology to contribute to Integrated Pest Management, agroforestry and rainfed farming systems.
- to undertake technology assessment on the potential of new biotechnology to contribute to the characterisation, conservation and utilisation of biodiversity by the farming communities.

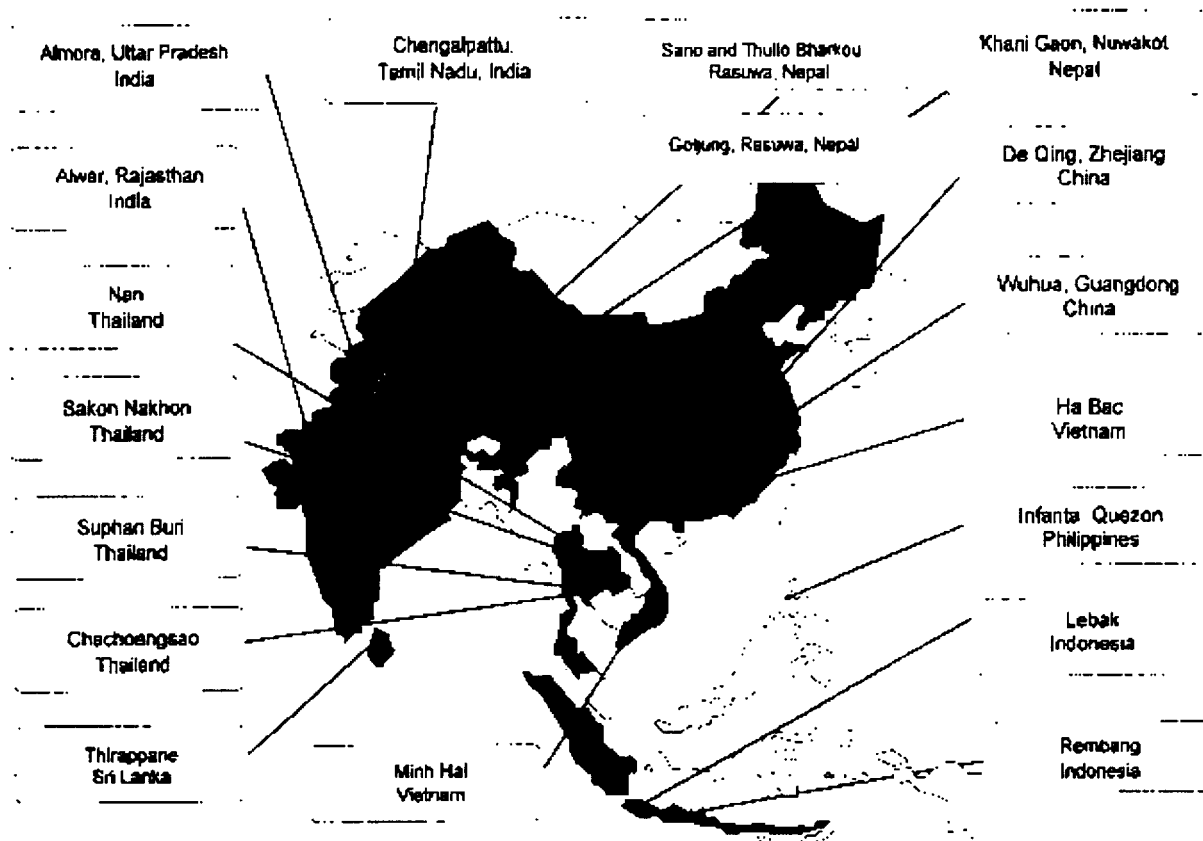
Long Term

- to assist member countries to achieve sustainable production within traditional farming systems.
- raise the socio-economic status of the small-holder farm households;
- conserve the natural resource base, including its biodiversity, through the application of environmentally sound technologies, including new biotechnologies.

The entire FARM Programme was radically modified in 1996 to principally address the needs of subsistence farmers utilising rain-fed agricultural systems through the provision of 18 field sites, scattered throughout the eight countries (as shown in the map below¹). These field sites would provide training, examples of technologies which might assist farmers to change their traditional practices, and allow the collection of information about traditional practices and the diversity of the flora and

¹ Leaflet produced by the Programme Support Unit: New Delhi describing the sub-programme on Asian Biotechnology and Biodiversity

fauna within the area. Despite the redirection of the Programme as a whole, the sub-programme on biotechnology and biodiversity remained essentially in place. The sub-programme has been co-ordinated by a support unit, known as the FARM Biotechnology Node, situated at the Department of Biotechnology, Government of India, New Delhi.



The 18 FARM field sites

2. Biotechnology and Biodiversity in the context of the sub-programme:

In terms of biotechnology, the scope of the technologies envisaged by the sub-programme included micropropagation (particularly of vegetatively produced crops), the introduction of bio-fertilisers, bio-control using 'biopesticides', 'bio-energy',

¹ "FARM Programme: bringing farmers to the centre of decision making", FARM Programme, FAO-RAP, Maliwan Mansions, Phra Atit Rd, Banglumpoo, Bangkok, 10200Thailand

vermiculture, mushroom culture and aquaculture — all of which are capable of being instituted at subsistence farmer level. Tissue culture techniques which allow, for example, the production of virus-free 'seed' can be used to improve yields in subsistence farming, and have been or are being used in the region. Technological know-how and training was to be provided mainly by government institutions. Given that FARM is conceptually based on farmer-led innovation the scope of rDNA technologies is marginal.

With regard to biodiversity the sub-programme attempts to help institute practices which "conserve and sustain the utilisation of plant genetic resources". The characterisation of biodiversity, the recording of 'traditional practices', and the compilation of corresponding databases were set as key objectives of the sub-programme. It is assumed that in most instances the collection of plants and their identification (and possibly retention in culture collections) would have to be instituted at field sites, but co-ordinated at Government level.

Bioinformatics¹ was to play a pivotal role in the implementation of not only of the sub-programme but of the FARM Programme as a whole. It was thought that the establishment of a Bioinformatics Network would not only be instrumental in reaching the set objectives but could also draw "together the extension and support services of both GOs and NGOs to work together with farmers as a multi-disciplinary team in an interactive way"

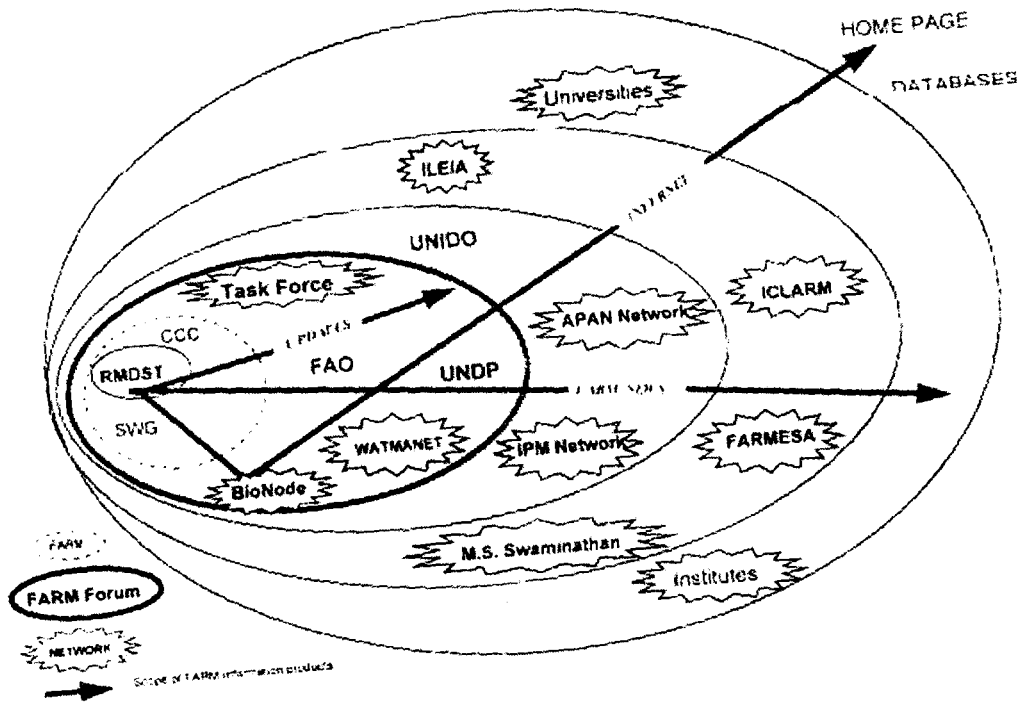
The Network was conceptualised as a multi-platform one utilising several means of information dissemination. A schematic representation of its operational structure is shown below. Its essence is summarised in "FARM Programme: bringing farmers to the centre of decision making" p. 32. "FARM in essence is a network of networks. It has the natural potential and niche to spawn a specialised network for rainfed agriculture in Asia and catalyse a movement to support rainfed agriculture.

¹ Bioinformatics is usually interpreted as the use of computers in solving information problems in life sciences; mainly the creation of extensive databases on genomes, protein sequences, etc. It is obvious that in the

In addition it has the capacity and potential to synergise and energise networking at various levels. The mission recommends that FARM proactively strengthen the linkage and networking relationship.”

context of the FARM programme this definition is inappropriate. The term is nonetheless used in this report as it has been accepted by the FARM Programme management

Network for rainfed Agriculture



3. Appraisal of information exchange within the sub-programme

The following means have been used for information exchange: the FARM Newsletter, reports and other publications, email and an Internet site. The relevance of these media is summarised below. The conclusions are the results of discussions with members of the Bioinformatics Network Nodes during site visits and a Workshop held in Bangkok, Thailand, 29 June – 3 July, 1998.

The FARM Newsletter is an important tool of communicating information within the system, but rather ineffective at communicating information at the national level. Reporting news and findings through the Newsletter could catalyse further direct bilateral communication amongst individuals involved in the Programme through fax, regular mail or email. On the negative side were the brevity of the articles and a reluctance of the workers involved in the Programme to submit material for publication.

The FARM internet site is maintained by staff of the Department of Biotechnology (DBT) in New Delhi. The existence of this site had remained largely unknown to the other bioinformatics nodes till the time of the Bangkok workshop mentioned above. None of the national nodes had been requested to submit information for inclusion on the site. Some network nodes have been contemplating to set up their own web pages and one node (Philippines) has already done so.

Email: all country nodes have access to e-mail facilities, though connections were often volatile and unreliable. This potential is not exploited within the sub-programme. E-mail has been used for occasional administrative communication between individual FARM nodes and the Biotechnology Node in Delhi, or the FARM co-ordinating team in Bangkok. It has not been used to communicate and/or exchange of information of technical nature. Lack of Email-based interaction is attributable mainly to lack of habit generally, and an overall reluctance to exchange information, rather than to limitations of computing infrastructure, or technical expertise. In most instances, available computing resources, and local computing

expertise should have permitted a far higher level of information exchange than is currently the case.

Production of one-off publications: there is a number of extremely good reports from several field schools held at the FARM sites but little evidence of their use.

Bilateral exchange of information (telephone, fax, letter): There is little bilateral exchange of information (again excepting administrative communication with either the DBT in Delhi, or Bangkok). Where communication is established this is the result of prior personal contacts. There is a general reluctance to send unsolicited information to, or request information from, other FARM nodes.

Although the above means of communication have an intrinsic value in general terms, none is specifically designed to effect information exchange in the subject matter of the sub-programme and have not led to a noticeable productivity enhancement of the FARM programme as a whole. The reason for this can be attributed to the fact that the scope of the Network was not adequately defined in terms of:

- end-user needs identification
- modalities of information generation & dissemination
- database design and maintenance
- task allocations and overall network co-ordination

The above might explain why there has been little or no communication between the FARM field sites and the assigned bioinformatics nodes. Furthermore, there have been resource limitations, at some if not all, of the nodes and, in cases, limited appreciation by co-ordinating committees of the potential of the Network to enhance productivity within the system.

Finally, at the national level, despite the fact that there were relatively few FARM sites within each country, information exchange amongst these sites has been, in most cases, poor. The central co-ordinating committees (CCC) overseeing the involvement of government, or academic departments and/or non-governmental

organisations have not been effective in ensuring communication amongst the involved parties. Again, this may have more to do with lack of incentives and the general reluctance to exchange information than to limitations of infrastructure.

The Bangkok workshop provided an opportunity to review the limitations and future prospects of the Network. Furthermore, it addressed issues related to the scope, architecture and management of the Network. An annotated workshop programme is attached as **ANNEX I**.

Participants concluded that the reasons which had been evoked for the establishment of network were still valid. Moreover, given the fact that the FARM Programme was to be terminated in 1998, there was considerable merit in maintaining the operation of the Network after the termination of the Programme if both the scope and the structure of the Network were adequately redefined.

It was agreed that resource-poor farmers in the region should be the ultimate target beneficiaries of the services provided by the Network. However, they could hardly be the primary users of the information provided by the Network due to field conditions (lack of infrastructure) and computer illiteracy. The target user group of the Network would be workers of extension agencies and non-governmental organisations (NGO) who function both as a channel of communication of farmer needs as well as a source of services and technology transfer. Extension agencies and NGOs are neither always well informed of technological possibilities nor of market conditions and more often than not rely on obsolete or obsolescent information.

The objective of the Network would, therefore, need to address the needs of extension workers and NGOs through the provision of value-added information services. The operation of the Network would depend on the effectiveness of collecting and compiling relevant information from intergovernmental agencies, stakeholders and farming communities and building up databases which can be used to enhance the work of extension officers, NGO's or groups committed to the improvement of resource poor farmers. Much emphasis would need to be placed on a bi-directional flow of information between resource poor farming communities

and all other agencies including the private sector. It was apparent that the content of most of the current databases were operating from a “top - down” approach. The inclusion of feed back reports in the databases from farming communities as a means of fostering a “bottom - up” approach in agricultural resource management was singled out to be of vital importance. The type of databases that would need to be built for the purposes of the Network are identified in **ANNEX II**.

It was also pointed out that while the Internet could serve as the backbone of the Network, it should not be the only medium of information dissemination as it is not yet available in many regional and district areas where extension agencies and NGOs operated from. Where Internet access is problematic the use of stand-alone multimedia (e.g. CD-ROM's) containing relevant databases was considered a useful alternative to information dissemination.

The merits of a regional Network were all too apparent. It would ensure economy of resources, sharing of expertise, know-how and information to mention the most obvious ones. The experience accrued from the implementation of the sub-programme pointed strongly towards the operation of a centrally co-ordinated distributed Network.

Collection and validation of data from and dissemination of information to extension services should be the responsibility of the National Focal Points (NFPs). The latter are expected to maintain national databases and provide information support services to interested parties in their respective countries. To effect data integration within the Network as a whole, the individual focal points would need to use identical front-end databases. NFPs would be responsible to select sub-sets of data to be made available to the Central Network Node.

The Central Network Node (CNN) would maintain the web site of the Network and provide links to relevant public-domain databases. In addition, would provide, as required, individual NFPs with assistance in terms of training and establishing their own national web sites. Furthermore, CNN is expected to ensure that the individual Focal Points are kept up to date with developments in the other member countries.

Income generation through the provision of services and grants from public institutions would be an essential pre-requisite for the viability of the Network. Income would be necessary for the maintenance of the Network as a whole and of the individual Focal Points. Such income could only be possible if the information needs of the primary user group were clearly identified and the quality of the services provided of high standard.

It was agreed that UNIDO would facilitate the establishment of a pilot Network with a view of testing its operation viability and public usefulness.

4. The establishment of the pilot phase of the Network

The project has proceeded in accordance with the agreed project plan. The following has been achieved (individuals responsible named in brackets):

- Technical project manager appointed (Mr Albert Ng)
- Programming staff appointed (Mr Bill Shui)
- Project functional specifications scoped (Dr Evans Laguda)
- Project directions and priorities defined (Dr George Tzotzos)
- Technical architecture scoped (Mr Albert Ng, Mr Camson Huynh, Dr Tim Littlejohn)
- Reporting procedure implemented (Mrs Helen Karuso)

Data distribution- the FarmWWW

The outcome of this project is a coordinated and distributed bioinformatics data system. This system includes systems for data collection from member countries (see below) and then distribution through a server in Australia (through the Australian National Genomic Information Service- ANGIS).

Data will be collected then deposited into a centralised database in a UNIX environment and RDBMS. The choice of these technologies was based on

ANGIS's extensive experience with them, their suitability for data collection, query and distribution through the WWW and the track record ANGIS has with similar projects, environments and technologies and suitable for the FARM database.

Development is guided by a committee with representatives from ANGIS, UNIDO and FARM member countries whose agreement is required for the scope, distribution, data collection, data maintenance and training needs (*FARM-IT committee*). This committee specifies, approves and oversees program, database, user interface and training materials development.

Data collection and updates

Data collection will be through two mechanisms:

1. A stand-alone Windows95 application will be distributed (with training material) to non-networked member countries on floppy disk. This application will be developed using MS-Access or an equivalent package
2. A WWW based data entry form accessed through the Internet (Australia)

Data updates will occur through the same mechanisms.

Training

Training material will be distributed as HTML documents on floppy disk (and read using local versions of Netscape- also provided, if necessary, on floppy or CDROM) or through the WWW directly (for member countries with network connections).

ANNEX I - ASIAN BIOTECHNOLOGY AND BIODIVERSITY

SUB-PROGRAMME OF FARM

WORKSHOP

29 June to 3 July 1998, Bangkok, Thailand

Annotated Programme

POLICY/MANAGEMENT SESSIONS

Presentation of the status of the overall Programme by the FARM management team. Potential of follow up

Review of the bioinformatics component of FARM Programme

Presentation of UNIDO's fact-finding mission report.

National delegates will be expected to contribute a brief presentations on the current status of the bioinformatics component of the FARM programme, reflecting upon on progress to date, and availability of resources.

Identification of end user information needs

Exploration of the requirements of the end-users, in particular the transferability of technologies within and amongst the participating countries. Definition of end users profiles, their respective information needs and identification of mechanisms to access such information? In particular, the form in which information should be

made available to the end users. Review of set precedents for information transfer, and initiatives taken to encourage its full dissemination.

Sources of information

What sources of information can be tapped from (i) the public domain and (ii) proprietary databases (iii) generated by FARM?

Delegates at the workshop will be expected to provide an inventory of databases in current use within the context of their national FARM sub-programmes.

Review of capacities at the national level

Infrastructure and human resource requirements for data exchange of the type reviewed above. Availability of resources at a national level (computing hardware and expertise, for example). How are these best exploited, and under which conditions?

Means of dissemination of information

Mechanisms to disseminate information in electronic and paper form will be explored. The role, and limitations, of electronic dissemination of data will also be reviewed. Means for strengthening the role of the FARM Newsletter and the possible use of national local-language newsletters will be explored, as a necessary approach to broadening the constituency of FARM workers with access to new information.

Network structure, management and operation

Review of network options will focus on the analysis of merits of managing a

centralised network versus a decentralised one in the light of programme needs and existing capacities and limitations.

Resource requirements

Resource requirements (e.g. infrastructure, financial and personnel) for maintaining a viable network.

OUTPUT: **Report**

Conclusions will form the basis for preparing an operational blueprint including task assignments for each individual network node.

Technical Sessions

Review of available information

Participants are required to bring to the workshop detailed summaries of technologies that are deemed appropriate for incorporation into a database.

Delegates will be expected to review the context and relevance of the available information and the means of integrating it into appropriate databases.

Database design and maintenance (standardisation)

Choice of database environments; maintenance of data in hypertext format, in flat and/or relational databases.

Standardisation of data input, conversion of available data into electronic form and data input. Choice of subsets of data to be made available through Internet. Web page design.

Email and file transfer protocols

Data access by email, news groups, telnet and ftp.

OUTPUT: Design of Web site, establishment of email news-group

The workshop will provide an opportunity to generate a database of current technologies and profiles of the relevant expertise of the individuals involved, as well as contact details of FARM focal points. It will also establish an e-mail news group, which will contribute to the free exchange of information - both with regard to the dissemination of technologies and administrative information developed in the context of the FARM Programme.

ANNEX II - Databases to be made available through the Network

The contents identified are as follows:

PHYSICAL, SOCIAL AND ECONOMIC

Farm habitat/site:

- location characteristics: temp, rainfall, type of soil etc eg. Bio Village
- farmer profile (sex ratio, gender, labour availability, income etc)
- farmers local and indigenous knowledge (plus non-farmer knowledge of site)
- cropping and livestock systems (eg. agroforestry, aquaculture, etc)
- farmers access to weather forecasting
- farmer needs (eg as assessed using participatory action planning with FARM sites)
- farmers feedback/response (examples of impact/adoption of successful biotechnologies in the region, and what is learnt from past mistakes, eg. nonadoption technology)
- soil and water management
- access to microfinance (credit and savings etc)

Policy:

- What issues (national, international) relating to biotechnology?
- How to ensure that farmers (in rain fed areas) benefit

- Guidelines (eg.pesticides, plant collecting, etc)
- Institutional and farmer linkages (eg extension agencies, NGO's etc)

Markets:

- Product development and marketing
- Commodity pricing and trends (eg. import/export)
- Production forecasting

BIOLOGICAL RESOURCES

Germplasm resources and sources:

- plant, animal, fish, microbial (eg genebanks, culture collections etc)
- landraces, improved varieties, breeders lines, wild relatives
- conservation sources/methods (in situ, ex situ)
- availability of useful traits (eg. characterisation of germplasm for drought tolerance, early maturing, product quality etc)
- crop and germplasm networks (eg. Asian rice biotech network, SINGER, Bamboo and Rattan Network etc)

APPLICABLE TECHNOLOGIES AND PRODUCTS

Plant and Animal Improvement:

- micropropagation techniques and materials
- Oestrus synchronisation - artificial insemination of water buffalo)
- cell culture techniques

Health, pests and diseases:

- biocontrol
- virus indexing and elimination
- diagnostics (eg monoclonal Ab kit for identifying disease free planting material)
- vaccines (eg pasteurilla vaccine for water buffalo) and how to administer
- probiotics

Post harvesting processing:

- food and resource processing techniques- fermentation, simple local level techniques
- medicinal uses

Soil and water:

- biofertilizers (eg Nitroplus, bio-N, mycogro, mycovam)
- soil and water management (cover and green manure crops, watershed management etc)

Alternative enterprises:

- mushroom production

Bioprospecting methodologies