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Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Program Biotechology

UNIDO Project DU/RAS/93/066

Contract No. 98/284

"Asian Biotechnology and Biodiversity: FARM Country Collection Data"

REPORT

CONTENTS

1. Background: *In situ* biodiversity conservation and FARM Asian Biotechnology and Diversity sub-programmme

Following the workshop for members of the Bioinformatics Network Nodes, held in Bangkok, Thailand, 29 June - 3 July, 1998, the need was identified for the compilation and dissemination of data bases comprising inventories of germplasm resources and strategies for their conservation.

The *in situ* conservation of both indigenous knowledge bases and biodiversity offers opportunities for strengthening both the economic base and employment opportunities in small rural communities, whilst presenting effective conservation incentives.

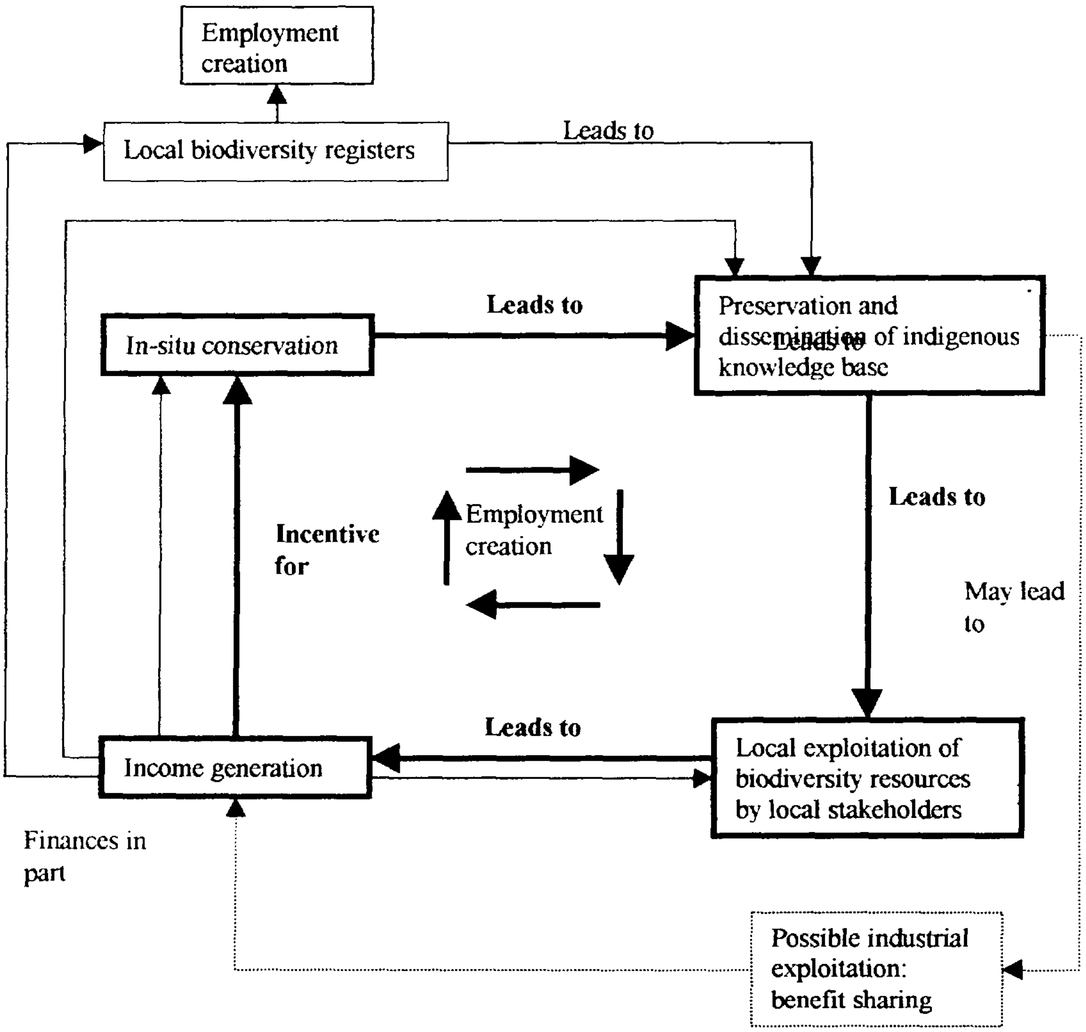
A stakeholder approach is based on the premise that the industrial exploitation of biodiversity for economic benefit is inextricably linked to a strengthening of the awareness of the value of biodiversity, and its conservation, at a local level. The most effective and economic strategy for biodiversity conservation is through developing the vested interests of local communities. Such vested interest is generated through a self-reinforcing 'awareness-exploitation-conservation' feedback loop. Thus the preservation and dissemination of an indigenous knowledge base presents opportunities for the commercial exploitation of biodiversity resources at a local level, generating employment. Income generation thus becomes an incentive for the continued *in-situ* conservation of biological resources, itself generating further employment opportunities. The preservation of local knowledge bases (which are drawn upon in the course of the commercial exploitation of biodiversity) are in turn contingent upon such conservation of biological resources.

Figure 1 develops the concept of a self-reinforcing feedback loop, with the addition of provision for the compilation of local biodiversity registers (a prerequisite for biodiversity exploitation). The figure also allows for the possibility of income generation from benefit-sharing with external industries. However, it is well documented that such benefit-sharing measures alone are unlikely to provide sufficient financial support for large-scale conservation projects. Hence the stakeholder approach stresses the development of the vested interests of community members themselves.

2. Establishment of a local biodiversity register

The pilot project considered:

- An evaluation of precedents
- Identification of existing sources of expertise amongst stakeholders.
- Optimal division of labour between taxonomists and local stakeholders
- Optimal levels of training for local collectors
- Optimal organisational structure for collection, taxonomic investigation, and cataloguing
- Assessing local employment prospects for the generation of such a register, both in the initial stages, and during its continued maintenance, and scope for income generation
- Possible technological requirements for taxonomy and cataloguing.
- Precedents for making the register accessible to outside industrial interests



Community-based conservation and exploitation of biodiversity

3. Strategies for maintaining and disseminating the indigenous knowledge base

Preservation of an indigenous knowledge base, and dissemination of this knowledge throughout a community is central to a strategy for biodiversity conservation.There are several existing precedents within the FARM project. For example, schools-based projects to strengthen community awareness of the range and value of local biodiversity in Sri Lanka. Other NGO precedents of value here are training of local women in medicinal plant use (RFSTE, India, for example) and the uses of local landraces of cultivated plants (Navdanya, India, for example). Dissemination of such knowledge will both (1) help develop local markets for biodiversity-based products (foods and medicines, for example) and (2) provide local people with the know-how to supply these markets.

The pilot project considered:

- An evaluation of precedents
- Optimal division of labour between professional workers in the medicinal and culinary use of biodiversity, and local expertise
- Identification of existing sources of local expertise amongst stakeholders
- Optimal approaches to training local women
- Optimal organisational structure for the dissemination of indigenous knowledge bases, through both resources for schools, and teaching for adults.
- Assessing local employment prospects for the generation of training networks, and scope for income generation

4. Local exploitation of biodiversity

As discussed, local industrial exploitation of biodiversity, and economic dependence upon this will lead to greater awareness of the need for biodiversity conservation amongst local people. Strengthening such economic incentives for biodiversity conservation will also generate employment through the development and application of appropriate technologies: micropropagation of landraces, and production and supply of seeding material, and technologies for the production, standardisation and supply of medicines

The pilot project considered:

- An evaluation of precedents
- An inventory of possible marketable products, drawing upon the biodiversity register (1, above)
- Potential for acquisition of appropriate technology, and requirements for local industrialisation of facilities for producing biodiversity-based products (food or medicines, for example)
- Business plans for the development and supply of markets in biodiversity-based products, and market potential
- Identification of existing sources of local expertise
- Optimal levels of training for local stakeholders involved in marketing biodiversity-based products.
- Estimates of possible income generation and employment provision

5. Benefit sharing

Benefit sharing cannot comprise the single economic base for biodiversity conservation. Nonetheless, opportunities exist for communities to benefit from economic remuneration following the use of their local biodiversity by outside companies.

The pilot project considered:

- An evaluation of precedents for benefit-sharing strategies at a local (rather than national) level
- Building legal infrastructures for making local biodiversity (as catalogued in (1) above) available to industry. Precedents in the form of benefit-sharing agreements will be considered.
- Devising approaches to benefit sharing that support conservation and economic exploitation of biodiversity at a local level through appropriate technologies (perpetuating the 'awareness-exploitation-conservation' feedback loop)

6. Conserving biodiversity

The commercial exploitation of biodiversity presents an incentive for its conservation. Under the stakeholder approach, emphasis is placed upon *in situ* conservation of biological resources. Such conservation is cost-effective and is also essential for the maintenance of a local knowledge base - itself prerequisite for the commercial exploitation of biodiversity.

The pilot project considered:

- Strategies and precedents for *in situ* conservation
- Resource requirements (financial and human)
- Probable employment generation

Drawing on the above, a strategy was devised for creation of a partnership programme, drawing upon the expertise of academia, NGOs and the private sector (see Figure 2).

7. Summary of information collated:

Specific national summaries appear in Appendix 1. Information has been collated in full in electronic form, and is currently being converted into databases, comprising some 1.2MB.

8. Summary of work undertaken:

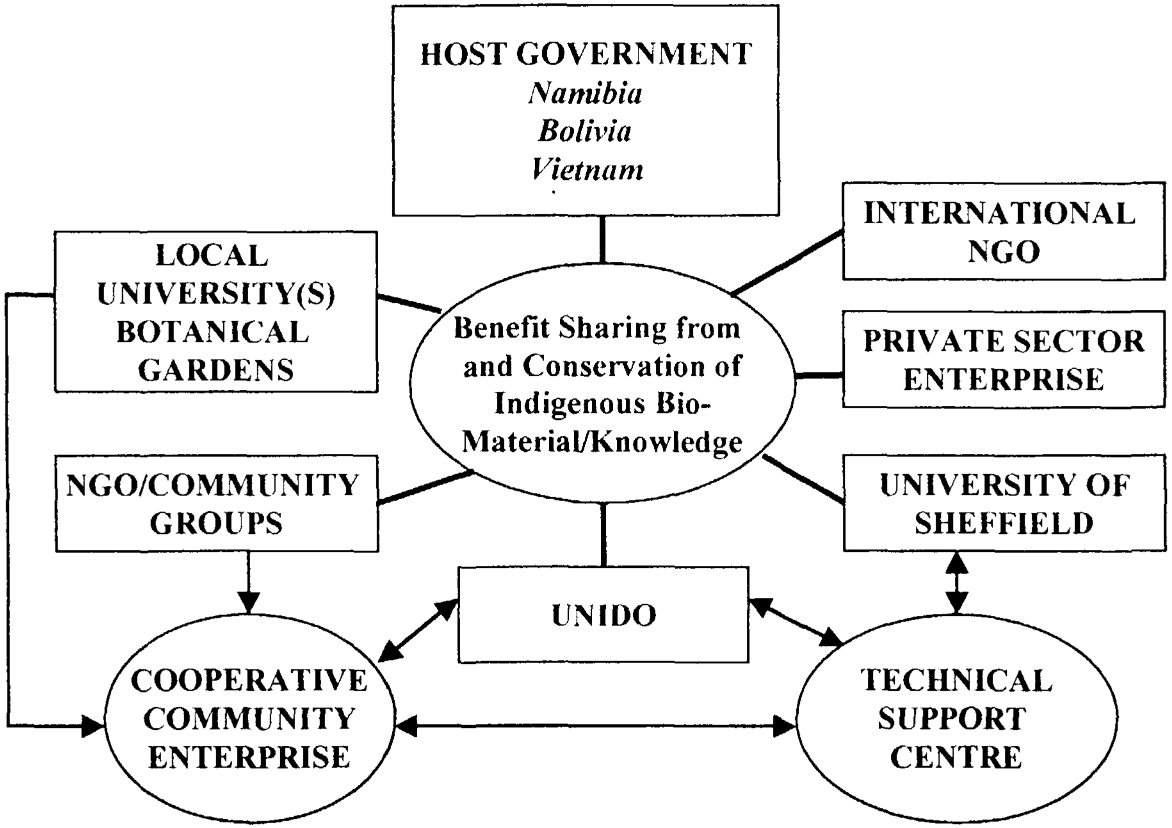
- **Compilation of data, as per needs identified during workshop of Bioinformatics Network Nodes, Bangkok, 29 June - 3 July, 1998.**

- **Analysis of data**

- **Electronic transcription of data**

Compilation of databases

UNIDO Partnership Programme: Benefit Sharing from and Conservation of Indigenous Bio-Material and Knowledge



Phase III: Country-wide Institutionalization of Benefit Sharing and Conservation Activities *(Establish a Technical Support Centre)*

- Credit facility
- Support for assessing technological needs
- Information services on: rights of individuals/ community groups in the area of bio-trade; policy/regulatory requirement; bio-technology/chemistry/botany, genetics; market information on bio-material
- Community-based institution capacity-building and HRD
- Fee-based technical support for research and analysis
- Awareness programme: market opportunities in bio-prospecting, conservation and indigenous rights

OUTPUT/ACTIVITIES

Phase I: Rapid Needs Assessment

- Assess credit requirements
- Evaluate appropriate technology needs
- Identify legal/regulatory barriers
- Stocktaking of available bio-material/ traditional knowledge

Phase II: Develop Framework for Benefit Sharing/Conservation

(Case Study Approach: Pilot Programme with Local Community Groups/NGOs)

- Formation of an operational cooperative/ community enterprise
- Establish access to credit schemes
- Forge infrastructure for transfer of appropriate technology
- Draft legal/regulatory framework to support cooperatives/community enterprise in bio-prospecting, bio-trade, and conservation
- Strengthen institution/HRD to increase local capacity to conduct research/analysis

APPENDIX 1: National Summaries

PHILIPPINES

Biotechnology Farm Village In Infanta, Quezon, Philippines[1/]

Introduction

Biotechnology Farm Village in Infanta, Quezon was funded by FAO, UNIDO and UNDP under the Asian Biotechnology and Biodiversity of the Programme Farmer-Centered Agriculture Resource Management (FARM).

The National Institute of Molecular Biology and Biotechnology (BIOTECH), University of the Philippines Los Baños (UPLB) in cooperation with Infanta Integrated Community Development Assistance Incorporated (ICDAI) as field site coordinator, implemented the project in 1995.

The development of a chemical fertilizer-based agrivillage into an organic fertilizer-based agrivillage is being done through the introduction and adoption of some existing biotechnologies which may help villages resolve some farm problems. Such technologies aim to increase farm productivity and farm income as well as provide alternatives to traditional farm practices.

The establishment of a pilot biotechnology village in Infanta, Quezon is an attempt to provide village communities with opportunities to improve their socio-economic status. The municipality of Infanta, Quezon has an aggregate land area of 24,278 hectares. The municipality is bounded in the north by Agos River, in the south by Real, southwest by Sta Maria, Laguna, east by Pacific Ocean and on the west by part of the Lamon Bay). It is about 145 kms. southeast of Manila. It is plain, hilly and mountainous that most of the areas can be easily drained during rainy season. Rainy season starts in October until January.

Infanta comprises 36 villages with a total population of 39,779. Majority of the people earn their living through farming and fishing. The town has a total agricultural land area of 3,920 hectares which are planted to rice, corn, coconut and vegetables.

Objectives

The overall objective of the project was to establish a pilot biotechnology village utilizing existing biotechnologies to provide alternatives in the improvement of the well-being and socio- economic conditions of small scale farmers. Specifically, the project intended to:

- Train rural farmers in the use and application of modern technologies.
- Test the effectiveness of the technologies in farmer-managed demonstration fields.

Methodology

Series of seminars and training cum workshops were conducted to keep farmers abreast on modern technologies. Through these activities farmers got direct insight on potential technologies that will be adopted in their fields.

Potential technologies chosen by the farmers during the trainings were demonstrated through actual applications in demonstration fields.

Farmers identified the technologies they wanted to adopt in their farms. They selected technologies that would benefit them most in terms of farm input and output. The field experiments on farmers' fields were conducted to test the effectiveness of the technologies and to compare the yields before and after the adoption of the technologies.

Likewise, they also requested artificial insemination for their farm working animals. The participatory process used in making decisions made the transitional phase smooth and efficient. Farmers with technical advise from researchers took the lead role in the actual implementation of the project.

Technologies Introduced

A. Bioorganic Fertilizer (BOF) Technology

Bioorganic fertilizer is produced from agricultural and agro-industrial wastes composted with suitable fungal inocula and enriched with free-living nitrogen-fixing bacteria. It contains sufficient amount of nutrients like nitrogen, phosphorus, potassium and other micronutrients such as vitamins and hormones. It is also used as soil conditioner.

Agricultural wastes such as rice straw, coffee hulls and corn stover and industrial wastes such as sugarcane baggase and mudpress and animal manure can be used in BOF processing. The processing takes about 3 - 4 weeks using the technology.

The shell life of BOF is 6 months however, it can still be used after the expiration date by adding the nitrogen-fixing bacteria.

BOF are applied basally to the field before planting. Five to ten sacks (50 kilos per sack) are enough to a hectare of land but this depends on the soil type and crops to be planted.

A ton of agricultural/industrial waste can produce about 10-14 bags of BOF. (One bag contains 50 kilos). BOF is used for all types of plants as organic fertilizer. Acutal production of BOF was demonstrated to the farmers in the field. They used rice straw and maria-mariahan (a wild grass abundant in farmers' fields) and cattle and chicken manure. Farmers produced 4 bags of BOF from 300 kilos of maria-mariahan composted and 14 bags of BOF from 1400 kilos of rice straw. The finished products were used for vegetables like eggplant and pole sitao.

B. BIO-N Technology

Bio-N is a microbial-based fertilizer for rice and corn. It contains microorganisms that can convert nitrogen from the air into ammonia and makes it available to crops and soil. It reduces the amount of inorganic nitrogen that a farmer has to apply to his crops. A pack of Bio-N can be used for 3 kgs of corn or 20 kgs of palay.

Bio-N is mixed with the seeds already moistened with water in a container. Coated seeds are then planted directly in the fields. Do not expose the coated the seeds under the heat of the sun. A hectare of farm needs only 5 packets.

Bio-N enhances the shoot growth and root development. It can replace 30-50 percent of the total amount of nitrogen requirement of the plant and can maintain the natural soil properties and fertility of the soil. Bio-N was introduced in Infanta where field experiments in rice were set -up using different treatments. The use of Bio-N showed a yield increase of 1.50 T/ha. when it was applied together with reduced amount of chemical fertilizers. Furthermore, its beneficial effect could be seen when it was applied with inorganic fertilizer only (Table 2). Yield data noted the advantage of using Bio-N over those plots supplied with about 4 bags of urea and about 25 bags of organic fertilizer (Table 3) Marginal benefit cost ratio of about 238.00 pesos was observed when Bio-N was applied alone. Farmers saw the benefit of Bio-N in terms of low production cost and yield increase (Table 4).

C. NitroPlus Technology

NitroPlus is a rhizobial inoculant for legumes like peanut, soybean, mungo, pole sitao, cowpea and pasture legumes. It is an effective and cheap substitute for chemical nitrogen fertilizer. This fertilizer substitute contains bacteria which has the ability to fix nitrogen from the air and convert it into a form usable by plants.

Nitro-plus is mixed with the seeds already moistened with water. Seeds coated with the inoculant are directly planted in the field. Inoculated seeds should not be exposed to sunlight. Peanut is the only legume most commonly planted in Infanta, hence, Nitro-plus for peanut was use in the farmers' field. A pack of Nitro-plus is good for 50 kilos of peanut. Peanut inoculated with NitroPlus showed increased nodulation at 2 weeks after planting (WAP) over the uninoculated treatment (Table 4). Peanuts were harvested after 111 days but continuous rain affected the results. Farmers decided to save whatever harvest could be obtained. In the process, yield data in all treatments were not obtained. However, farmers experienced harvesting 30-40 pods per plant as compared to their usual harvest of 15-30 pods per plant.

Mean pod yield obtained from farmers' variety was 639 kg/ha for uninoculated plants and 919kg/ha for inoculated. There was 44% increase in yield in farmers' variety due to inoculation. For UPL Pn 10 variety, pod yield was 1,464 kg/ha for uninoculated and 1,613 kg/ha for inoculated plants. There was a 10 % increase in yield for plants inoculated with NitroPlus

(Tables 5&6). The farmers' variety was more responsive to inoculation than the introduced variety.

D. Estrus Synchronization and Artificial Insemination

Estrus is synchronized while the animals are in heat. Artificial insemination (AI) is the deposition of semen in the reproductive tract of female animals by artificial means (injection). Estrus synchronization were done to 42 farm animals to check if the animals are ready for pregnancy. Of the 42 carabaos examined, 10 were artificially inseminated and the rest were still too young or already pregnant, of the ten carabaos artificially inseminated, only 3 progressed.

E. Mushroom Production

Mushroom grown on rice straw was introduced immediately after harvesting palay. Farmers prepared all the materials needed such as rice straw bamboo and plastic/net. Mushroom spawns were placed in heaps of rice straw but it did not produce good flushes because of contamination and poor weather conditions. This technology was discontinued.

Summary

The project gave an insight to farmers that modern technologies can be beneficial to agriculture. The use of these technologies like biofertilizers lessen or minimize the application of chemical fertilizers. Most of the farms in Infanta are planted to rice, corn and peanuts. Among the technologies introduced, BIO-N and Nitro-Plus are the most commonly used and can be sustained by the farmers. They can also be introduced or replicated in other farms in the area. A massive campaign on the use and application of these technologies should be conducted to enable more farmers to benefit from them.

INDONESIA

The Farmer-Centered Agricultural Resource Management (FARM) Program is a five-year Regional Program started in September 1993 to support and implement the provisions of Agenda 21 in Asia. The member countries of the FARM Program is China, Indonesia, Nepal, Philippines, Thailand, Srilanka and Vietnam.

The purpose is to achieve the sustainable use and management of natural resources for agriculture, household food security and improved rural livelihoods. The focus of the program is in rainfed areas. The priority is to work with resource poor communities.

The objectives of the FARM Program is to enhance the capabilities of resource poor communities and farmer in Asia for equitable, sustainable development in order to achieve improve conservation, management and utilization on natural/agricultural resources and systems through participatory approaches.

The approach is taken to enhance the capabilities of Governments and Non-Governmental Organisations (NGOs) as the multi-disiplinary support services to build local capacities of rainfed resource poor communities to improve household food security, alleviate poverty and improve their quality of life. These aims are to be achieved through gender sensitive participatory approaches in decision making which utilize and enhance their natural resources on a sustainable basis.

The FARM Program was completely re-tunned by the end of March 1996. Since then, the previous of seventh Sub-programs (Integrated Pest management, Agroforestry, Rainfed Farming Systems, Biotechnology & Biodiversity, Watershed Management, Pesticide production and Information, and People Centered Sustainable Development) were merged under the coordination of the Country Coordinating Committee (CCC) which chaired by the Head of International Cooperation Bureau, Ministry of Agriculture. Regional Multi-Disciplinary Support Team (RMDST) provides assistance in developing a national FARM Strategy to institutionalize the FARM approach to support agriculture in rainfed areas.

National FARM Program

During the Second Long Development Plan (PJP II) started in 1994, the agricultural development objectives have shifted from mainly production oriented to increasing farmers' productivity, incomes and welfare. The new national strategy focusses on the development of commercial farming, agribusiness, and agro-industries in rural areas. This focused strategy will invite greater private sector involvement, as a mean of increasing farmers' incomes, rural employment opportunities, and augmenting value added of agricultural products within the region.

Along with the major goal of poverty alleviation, increased emphasis will be accorded to regional development. This is supported both through development expenditures carried out by the Central Government and through transfers to regional government to help finance development program for which the implementation responsibility rest with local governments. Continued decentralization of development planning, finance, and program implementation arrangements will be important policy thrust supporting regional development.

In Indonesia FARM Program, the role of GOI and NGOs are very significant started from the central government to the district level government. The main activities of FARM program in Indonesia have been on technology assessment and demonstration, strengthening the network among participating agencies, training for government staff and farmers, and policy analysis for sustainable agricultural development.

One of the key objectives of the FARM Program is to develop a conducive policy environment for rainfed agriculture as a means to promote the sustainable management of natural resources, alleviate rural poverty and attain household food security through gender sensitive participatory approaches. FARM Program for across rainfed ecosystem can be designed in a watershed perspective started from the upstream area to the downstream. The program is implemented either at rainfed upland or at raifed lowland.

During the first phase of FARM project it was decided that Rembang District, Central Java, was chosen to be the FARM field site since this area provided a comprehensive overview of problems and development priorities. Water was seem as a primary constraint since there are no rivers in the district and it rains only about 3-4 months per year. The district is classified among the poorest in Central Java. Human resource development and poverty alleviation are also priorities. FARM activities are implemented at Pinggan and Megulung villages.

During the second phase of FARM Program, the project was extended and replicated. The second field site was then established in the District of Lebak in West Java which also depends solely on rain for agriculture. Activities of FARM project in this area are implemented at Sudamanik and Sukamarga villages.

Rainfed Land Area

Among the marginal land, rainfed land is the most prospective land that can be utilized for the sake of agricultural development. In Indonesia, this type of land accounted about 2.19 million hectares. About 840 thousands hectares in Java and about 1.35 million hectares spread over in outer islands. Availability of water is the most limiting factor of this land and farming activities is very much depend on rainfall. However, in some areas deep wheel pomp irrigation have been developed to increase land productivity and farmer income. Other technique has also been developed such as rainfall water harvester (*embung*). Dry direct seeding rice (*gogo rancah*) has also developed at main rainfed lowland ecosystem. These techniques have increased cropping intensity more than twice a year. On the other hand, soil and water conservation based farming system in some areas has been well adopted by upland farmers. Nevertheless, priority commodity should be prioritized to increase farm income for resource poor farmers which mostly live at this rainfed ecosystem.

The rainfed lowland bears a great potential to be intensified for food crops production. Poor management of water resources, soil fertility, and lack of support systems are major factors affecting optimum utilization of agricultural resources in rainfed areas.

In rainfed lowland, the water supply generally excess during the wet season and greatly scarce during the dry season. In Pati and Rembang districts which cover about 60.000 ha of rainfed area have developed their agricultural activities by using farm water collector during the dry season. Many farmers have augmented the rain water and run-off water into farm water collector (*embung*) during the wet season and used the water during the dry season for irrigation, households need, cattle and fish cultures.

Generally, infrastructure at the lowland rainfed is better than upland rainfed since farmers at the rainfed lowland are mostly growing rice as their base crops in farming systems and usually has better infrastructure conditions. It is common that at rice production areas the infrastructure is more accessible compared to other zones. However, at regional level infrastructure is not the main constraint at rainfed areas in Java but in outer islands, to some extends, infrastructure is becoming the main limiting factors.

Land Use and Farming Systems

Agricultural land use in Indonesia is grouped into lowland and upland. Meanwhile, lowland is further grouped into rainfed lowland, irrigated land, swamp and others.

Rice base farming system is commonly practiced by farmers at irrigated lowland. The yearly cropping pattern is mostly following the sequence such as : (1) *rice-rice-palawija*, (2) *rice-rice-vegetables*, (3) *rice-rice-follow*. Meanwhile the cropping pattern at rainfed lowland mostly as follow: (1) *rice-palawija-palawija*, (2) *rice-palawija-vegetables*, (3) *rice-vegetables-vegetables*, (4) *rice-palawija-follow*, or (5) *rice-vegetables-follow*. Palawija crops that commonly grown at rainfed lowland are maize, soybean, groundnut, mungbean, and sweet potato, and common vegetables are onion, chili, stringbean and other lowland vegetables. The cropping pattern at upland area that commonly practiced by farmers are : (1) *upland rice-palawija (intercrops)-palawija*, (2) *upland rice-vegetables-vegetables*, (3) *palawija-vegetables-vegetables*, (4) *vegetables-vegetables-palawija*, and (5) *other intercropping among palawija or vegetables crops*. Intercropping between food crops (rice and palawija) and tree crops is also practiced at upland area. Palawija crops like maize, cassava, soybean, or groundnut are commonly grown at rainfed upland. Meanwhile, vegetables are mostly grown at upland raifed areas include potato, cabbage, onion, and other fresh vegetables.

Activities at the field site of Rembang District (Central Java)

The District of Rembang is about 15-25 m above the sea level and located in the north east part of Central Java. The temperature ranges from 26 to 35°C. Soil type is alluvial, hydromorf, planosol, and grumusol association. The total land of Rembang District is 101,408 ha in which 60% of it is a rainfed lowland. The average annual rainfall is about 1500 mm, with the wettest month in January. The total raifall in May to September (dry season) was less than 100 mm where it was not enough to water the secondary crops. Many farm reservoir (embung) have been built by farmers to meet the requirement of the secondary crops.

Pinggan and Megulung villages have been selected as a "Center of Excellence" for the FARM Program. The total area of Pinggan village is about 466 hectares which consist of 80.8 ha of paddy field, 307.9 ha of tegalan and 77 ha of forest. Crops that commonly grown are rice, maize, groundnut, mungbean, chili, cucumber, watermelon, tomato and cassava. Annual trees that have been intensified grown are mango, coconut, spondias (kedondong), rambutan, jack fruit, leuceana (lamtoro) and mahogani. While the total area of Mengulung village is 110 hectares with about 301 households.

As a final result of the PAP (Participatory Assessment and Planning) training, the needs, problems and potentials of those two selected villages were identified. Then following these activities by preparing a development plan and a work plan for each community as it were shown in Table 2 and 3.

Table 2. Development plan and work plan for Mengulung village

Development Plan	Work Plan
• Water supply for agriculture and livestock	• Deepen existing reservoir
• Re-greening of village road Village nursery	• Collect funds and prepare holes Land allocation and preparation
• Asphalt the village road	• Look for funds Make proposal
• Livestock training-chicken	• Chicken vaccination
• Make cakes and sweets	• Training
• High yielding variety of rice	• Rice for dry condition & mix

• Agricultural technologies • Collect rain water from roofs • Boring wells for drinking water Install pump Collect rain water from roofs	cropping • Training • Self-help at every households

Table 3. Development plan and work plan for Pinggan village

Development Plan	**Work Plan**
• Lack of agricultural technologies - upland rice - mix cropping - diseases on chili, onions, groundnuts - goat worms - mango loss of flower	• New varieties Inter cropping Expert visit
• Establish women group for industry	• Preparation of jamu, sweets, cakes and sewing dresses
• Establish men group for wooden industry	• Produce furniture and trading
• Up grade village road	• Up grade 300 m road Look for financial assistance
• Bring electricity to the village	• Look for funds and ask electricity company
• Drinking water supply	• Connect water source through pipes Look for new water resources

Main activities priorities by farmers at those selected two villages were identified and they are shown in Table 4 Meanwhile, the implemented activities carried out at both villages in Rembang district is shown Table 5 and 6.

Table 4. Main activities identified by farmers in Mengulung and Pinggan villages

Mengulung community	**Pinggan community**
Infrastructure : • Asphalt village road • Boring wells for drinking water	**Infrastructure :** • Up grade village road • Electricity
On-farm :	**On-farm :**

• Chicken diseases, vaccination • New high yield rice variety • Agricultural technologies	• Upland rice varieties • Mix crops • Goat diseases • Mango loss of flower
Common resources : • Water supply, reservoir • Re-greening of village road	**Common resources :** • Drinking water supply
Off-farm : • Women IGA, food making	**Off-farm :** • Woman IGA, food making • Men IGA, furniture made

Table 5. Implemented activities in Mengulung village

Identified Activities in Mengulung	**Implemented Activities**
Water supply	Deepen existing reservoir (embung)
Re-greening of village road	Tree nursery training & establishment
Asphalt the village road	
Livestock training-chicken	1 day training on chicken vaccination
To make cakes and sweets	Women training on : • Fermented soybean (tempe) • Fermented nata de coco
High yielding variety for rice Agricultural technologies	Training on : • cropping system • banana planting from tissue culture • bio-rhizobium fertilizer • agro-forestry in backyards • use of rice straw biomass • mango grafting
	Demonstration of : • fish culture • paddy rice management
Boring wells, install pumps and Collect rain water from houses' roofs	
	Group leadership training Saving scheme training Fund for IGA

The promotion of water reservoirs (embung) development created demand among dryland farmers for water. The demand was created as a consequence of their realization of the possibility to grow their crop in a certain pattern through out the year under tight schedule that had not been possible before the introduction of this water management.

Introduction of applied biotechnology have been demonstrated and carried out in four days course with lectures, discussion and also direct practice. Farmers' wife have been trained to make good quality of fermented foods such as tempe and biocellulose fermentation (nata de coco) to improve their skills and to increase households income. Farmers were also trained to use bio-rhizobium fertilizers to improve soil fertility of soybean plants and also to plant banana planlets derived from tissue cultures which are disease free (panama disease). New rice varities, mix crops, tree nursery establishment (albizia, leuceana, mango, durian etc.), and fresh water fish culture were introduced as field demonstration. Pest management in chili and other vegetables was also lectured and demonstrated. Chicken vaccination was also undertaken through one-day training. The promotion of fish culture in farm reservoirs has been undertaken through demonstration of the practice on farmers' site. A group of farmers were trained for a couple of days by agro-forestry officers in order to promote tree nursery. The location of this promotion will then become a center for re-greening.

Table 6. Implemented activities in Pinggan village

Identified Activities in Pinggan	**Implemented Activities**
Lack of Agricultural technologies • Upland rice • Mix crops • Diseases on chili, onions, groundnuts • Goat worms • Mango loss of flower	Training on : • Cropping system • Banana planting from tissue culture • Bio-rhizobium fertiliser • Agro-forestry in backyards • Use of rice straw biomass • Mango grafting • Chili pest control Demonstration of rice field Test of : • New 6 rice varieties • New corn varieties
Establish women group for industry	• Training on fermentation of tempe and nata de coco • Making and marketing of sweet cakes, cassava & crackers
Establish men group for industry	Training on making and marketing furniture (cupboard, chair)
Up grade village road	Graveling and asphalt
Bring electricity to the village	Pillars has been placed
Drinking water supply	Water piping (2 km)
Capacity building	Group leadership training Saving scheme training & funds for IGA

Activities at the field site of Lebak District (West Java)

FARM Program which has been intensively implemented in Rembang, has been extended and replicated into villages of Sudamanik and Sukamarga, at Lebak District, West Java. Lebak District was chosen since this rainfed area having a different characteristic compare to Rembang. The District Government believes that one way of promoting replication and expansion was to start a training and demonstration center for community development and raifed agriculture in Lebak itself. All the approaches which have been done in Rembang District will also be implemented in Lebak District.

Lebak District has more than 300 villages. The FARM field site covers only two villages, Sudamanik and Sukamarga. The center is a 10 hectares land area, ideal for improvement of soil fertility, cultivating rainfed crops for demonstration and for establishing community seed bank on rainfed crops. In addition livestock and poultry breeding demonstration is also possible.

Applicable technologies

A. A small farm reservoir

Embung is a small farm reservoir that collects excess water from rain during rainy season to provide water for crops and cattles during the dry season. Embung can also be used to raise fish during the rainy season. The size of an embung depends on the amount of land owned by the farmer and the type of crops to be watered. Ideally it is 1 – 2% of the farming area. For example, a 50-square meter-embung (10m x 5m) with 2.5 – 3 m depth is enough for supplying water to 0.25 – 0.5 ha of land.

Even though it is not difficult to build an embung, there are several criteria that should be taken into account to make the embung effective. The criteria are:

1. Soil texture

The soil texture which is suitable for an embung contains a mixture of clay, sand, and dust in equal amount. This kind of soil is not easy to crack when it is dry and has low rate of water loss through seepage and percolation.

2. Topography

An embung is filled up by run-off water from rain. Therefore, the ideal area for an embung is flat or undulating land with the slope around 8 – 30 %.

3. Location

It will be easier to fill up an embung if it build near a canal. The embung should also be close to the farming area because this will save some energy in watering the crops.

It is not necessary to use mechanical equipment to build an embung. Although such machine surely can save time and energy, several farmers equipped with traditional tools are enough for digging an embung. There is no strict procedure in constructing an embung. The followings are served as guidelines in preparing an embung:

1. The ideal shape of an embung is square or close to a square. The purpose is to obtain the shortest perimeter in order to minimize the water loss through seepage.

2. The soil from the excavation is piled up to make an embankment enclosing the embung. This embankment is to prevent any materials which is carried by the run-off water from entering the embung.

3. An inlet and drain is placed about 25 – 30 cm from the top of the embankment to prevent water inside the embung from being overflowed.

4. The interior wall of the embung is cut off to an inclination about 70° - 80°. Alternatively, the wall can be made like stairs to avoid erosion.

5. In order to minimize the loss of water through seepage and percolation the interior wall and the base of the embung is covered with some protection layer. The layer can be made of a mixture of quicklime and clay, plastic sheet covered with clay, or concrete wall.

6. The embung can be equipped with some stair steps to make it easier in withdrawing the water.

B. Nata de Coco

Nata de coco is made from coconut water which is abundant and almost neglected by most people. With the help from *Azotobacter xylinum*, a useful microorganism produced by R&D Centre for Biotechnology, this coconut water is converted into some cocktail. The production of nata de coco is a kind of income generating activities.

The followings are the procedures to make nata de coco:

1. The coconut water is collected from several coconuts, and then stored for at least 3 nights.

2. Some amount of sugar, ZA, and citric acid is added to the coconut water. This mixture is then transferred into several plastic trays.

3. Every tray of mixture is then inoculated with *Acetobacter* sp. MN-1 as the starter.

4. Let the trays until all the mixture turn into a solid gel containing mostly cellulose. This process takes 7 – 10 days.

5. The slab of cellulose gel is then chopped into cubicles.

6. Those cubicles is washed and deep soaked for one night.

7. The cubicles is then boiled. Some amount of sugar can be added according to taste.

8. The nata de coco is ready to be served as cocktail.

C. Tempe (Fermented Soybean)

Tempe is a traditional fermented food from Indonesia. The main ingredient of this food is soybean, which is turned into tempe through a fermentation process by *Rhizopus oligosporus*.

This tempe inoculum is prepared by the R&D Centre for Applied Chemistry. Tempe can also be an income generating activity.

The procedure to make tempe can be described as the followings:

1. The soybean seed is cleaned and then boiled for about 1 hour.
2. Then the seed is soaked overnight.
3. The seed coat is then removed to make the seed split off.
4. The split seed is steamed for about 0.5 hour.
5. After this ingredient cool downs, it is inoculated with the tempe inoculum, *Rhizopus oligosporus*.
6. Then, the soybean seed is stored at 30 °C for 1 day.
7. After that fermentation process the tempe is ready for further preparation (cooking or frying).

D. Biofertiliser Rhizobium

The Laboratory of Microbiology, R&D Centre for Biotechnology has been able to produce Rhizobium biofertilizer. The Rhizobia used in the biofertilizer were isolated from nodules of soybean. The selected isolates that have already been proven capable of living symbiotically with soybean plants, producing root nodules, and fixing nitrogen were mixed and packed in carrier media originated from peat soil.

The procedures for the application of the biofertilizer are very easy. First, the soybean seed is mixed with the Rhizobia substrate until all seed is covered with the substrate. The seed is then planted in the usual way.

The application of Rhizobia inoculant gives better growth of the plants.

E. Planting micropropagated bananas

Provision of micropropagated Ambon Hijau and Cavendish bananas is conducted in the Laboratory of Plant Cell and Tissue culture, R&D Centre for Biotechnology. Cavendish banana is chosen because of its resistance to the wilting disease caused by the *Fusarium oxysporum* fungi, while Ambon Hijau is the most preferable banana in West Java.

The procedures for micropropagating banana are as the followings:

1. Explants are obtained from shoot tips of young banana.
2. The explants are cultured on MS medium containing 5 mg/l BAP growth hormone.
3. Shootlets are subcultured to a fresh medium every 4 weeks for their multiplication.
4. Within 8 weeks, 10 – 12 shootlets will appear and are ready for further development.
5. Shoot maturation is then promoted on MS medium containing 2 mg/l BAP.
6. Rooting of planlets is induced both in the absence of IBA and in the presence of 1 mg/l IBA.

7. Acclimatization of planlets is done by transferring them into pots containing soil and compost. These planlets is then placed in a green house for 2 – 3 weeks until a new leaf appears.

8. After new leaves appear, the banana is ready to be planted in a farming area.

F. Application of agriforestry system

Agroforestry applies mix cropping system in order to maximize the utilization of land. In order to implement the mix cropping system in any area, the followings considerations should be taken into account:

1. The types of plant chosen can grow optimally in that area.

2. All of the chosen types can grow together in the same piece of land so that the land can be used maximally.

3. The types of plant should have a high value and good market.

In Rembang, several vegetable species are planted under a tree stand. The vegetable species are egg plant, spinach, and cabbage. The selected tree species are albizia, leuceana, mango, and durian. Some of these tree species are usually utilized for furniture, firewood, light construction, fertilizer, while the other are planted for their fruit. Thus, those trees can provide more income to farmers.

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