

REGIONAL RESEARCH A NEW CONCEPT OF AGRICULTURAL DEVELOPMENT

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That agricultural productivity can only be improved by the application of science and technology is an accepted fact. About three decades ago there was considerable optimism that technology conceived in the industrialized countries would solve the problems of agriculture in the developing countries. "Package programmes" in terms of high-yielding cultivars, intensive cultural techniques including increased levels of fertilizer and other agrotechnological inputs were consequently recommended for adoption.

The Agricultural Research Station at Maha Illuppallama, and later the Central Rice Breeding Station, Batalagoda, were established in the 1950s to evolve improved cultivars and cultural techniques, with back-stopping facilities provided by the Central Agricultural Research Institute at Peradeniya. The tacit assumption was that alien science and technology would transform the traditional systems obtaining here into successful "copies" of those prevailing in the countries of origin.

Nevertheless, the expected "green revolution" did not materialize, and it soon became apparent that this technology, more often than not, was out of balance with the local environment and socio-economic conditions. The ensuing world inflationary situation and the escalating prices of critical agricultural inputs—all of which are imported—served to highlight the radical imbalance of 'sophisticated' technology in the context of an impoverished peasant economy.

AGRO-ECOLOGICAL REGIONS AND RESEARCH INFRASTRUCTURE

It was imperative, therefore, to restore this imbalance and narrow the gap that existed between the findings of research technology and their application in the field by rehauling the existing research infrastructure. The first step in this direction was to classify the different agro-ecological regions in terms of elevation, topography, rainfall, temperature, soils, and establish a wider-based and more meaningful research structure which could cater more efficiently to these physical differences and their impact on the system of agriculture practised by farmers.

On this basis 22 agro-ecological regions were identified (Land & Water Use Division, Peradeniya), and for practical purposes 8 major agro-ecological regions were established in 1977, on which all research and extension

activities have since been planned. Eight Regional Research Centres and their attendant Experimental Stations were accordingly set up to service these eight regions:

Regional Research Centres and Experimental Stations

<i>Region</i>	<i>Regional Research Centre</i>	<i>Experimental Stations</i>
1. Northern Dry Zone	Kilinochchi	Thirunelvelly Paranthan Murunkan
2. North-Central Dry Zone	Maha Illuppallama	—
3. Eastern Dry Zone	Karadian-Aru	—
4. Southern Dry Zone	Angunakolapalessa	Ambalantota
5. Up-country Wet and Intermediate Zones	Bandarawela	Rahangala Bibile Moneragala Vanathavillu Kalpitiya
6. Low-country Intermediate Zone	Makandura	—
7. Low-country Wet-Zone	Bombuwela	Bentota Labuduwa Pussellawa
8. Mid-country Wet Zone	Peradeniya	—

In addition there are the following research institutions which handle specialized functions on an island-wide scale:

1. Central Rice Breeding Station, Batalagoda, which is mainly responsible for breeding improved cultivars for the stable rice growing environments with assured water supply, good drainage and sunny weather;
2. Land, Water Use and Soil Conservation Division, Peradeniya, which provides the necessary resource capability surveys and conservation techniques on which improved cropping systems may be based;
3. Potato Research Station, Sita Eliya, which is responsible for the breeding of adaptable, high-yielding, pest and disease resistant varieties of potato.

There are also two Research Stations at Giriandurukotte and Aralanga-wila mainly concerned with cropping patterns and water management studies in Systems C and B of the ongoing Mahaweli Diversion Program.

The functions of the eight Regional Research Centres and their Experimental Stations have the common objective of developing (1) improved crop cultivars and cultural techniques and (2) improved cropping systems to suit the physical requirements of the different agro-ecological regions in which they are located.

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IMPROVED CULTIVARS AND CULTURAL TECHNIQUES

The development of improved crop cultivars and cultural techniques in cereals, millets, grain legumes, roots and tubers, condiments, fibres, oil crops and horticultural crops is a major objective of the research programme.

Rice

Rice being the staple food was given top priority. Low-yielding and disease-prone local cultivars were gradually replaced with the high-yielding and disease-resistant H and Bg series of hybrids released by the Central Rice Breeding Station, Batalagoda (Weeraratne and Senadhira, 1981). Although these hybrids have made a distinct contribution to boosting overall rice production since 1958 bringing us to the threshold of self-reliance, they have been found wanting in areas where rainfall or irrigation is in short supply, where soils are poorly drained, alkaline, saline or iron toxic, where flash floods are a recurring hazard, and where overcast skies and cold climates are limiting on production.

Consequently the breeding and testing of alternative and more adaptable varieties for these "problem" areas has been taken over by the Regional Research Centres and their Experimental Stations. Encouraging results have already been obtained at Bombuwela (Peiris, 1981) and Ambalantota with the release of the Bw and At hybrids respectively. Promising results are also expected from Maha Illuppallama, Paranthan and Bandarawela where water is a limiting factor. Rice research at Bentota is directed to developing flood-resistant varieties, and at Murunkan a potentially productive region, difficult soil management problems in the grumusols are being investigated.

Co-ordinated Rice Varietal Trials at the national level are co-ordinated by the Central Agricultural Research Institute, Gannoruwa.

Fertilizer. An equally important facet of rice research was the development of fertilizer recommendations dependent on varieties, soil and climatic conditions. The first set of recommendations based on the All Island Rice Soil Fertility Survey conducted in 1964 was improved in 1967, 1971 and 1979 (Nagarajah, 1980). With the onset of the energy crisis, however, and escalating fertilizer prices which threatened to lessen fertilizer inputs and thereby jeopardise the levels of rice production already achieved, a part of the research effort was directed to determining alternative sources of low cost organic manures and biofertilizers, and increasing the efficiency of nitrogen fertilizers via the use of slow-release nitrogen fertilizers and deep placement methods.

Experiments at the Central Agricultural Research Institute, Peradeniya, have shown that when the straw from a rice crop is returned to the soil it provides all the potassium requirement of the crop and upto 30 percent of the

nitrogen requirement, besides silicon, important micronutrients and valuable organic manure. New fertilizer rations have accordingly been recommended for the Kandy, Kegalle and Matale Districts including straw and a reduced quantity of inorganic fertilizers. Such recommendations will be extended to the other districts as and when the ongoing experiments are concluded.

Biofertilizer experiments with Azolla (*Azolla pinnata*) containing symbiotic blue green algae (*Anabaena azollae*) are also being conducted at the Central Agricultural Research Institute, Peradeniya and the Ambalantota Experimental Station. Depending on the availability of water, azolla can provide 50–80 kg of N/ha and an estimated biomass of 20–25 t/ha. Local strains of azolla and introductions from Vietnam, India and Thailand are being used in the experiments at Peradeniya and Ambalan'ota.

Pests and Diseases. With the increased use of fertilizer the new improved rice varieties developed succulent stems and leaves which caused a greater incidence of certain pests and diseases; e.g. Brown Plant Hopper, Gall Midge, Leaf Roller and Stem Borer: they also became susceptible to diseases like Bacterial Leaf Blight. Plant breeders at Batalagoda and other rice breeding stations have therefore turned their attention to breeding resistant varieties with the help of plant pathologists and entomologists at the Central Agricultural Research Institute, Peradeniya, where improved laboratory and greenhouse facilities exist. They have achieved some success with Gall Midge, Brown Plant Hopper and Bacterial Leaf Blight (Wickremasinghe, 1980; Seneviratne, 1980).

Quality. Now that a more stabilized rice economy has been established with an overall increased output, more attention is also being given to improving rice quality. Rice quality is comprised of several components including grain size and shape, colour of testa and milling performance. Rice breeders have developed several improved red rices to meet the demand in certain parts of the island; they have also produced higher yielding samba types which are more responsive to fertilizer application and more resistant to serious pests and diseases. In order to enable millers to produce a better market quality of rice with less breakage, a grain size code has also been drawn up to help breeders confine their selections to a lesser number of grain sizes. Rice quality tests are carried out at the Division of Cereal Chemistry in the Central Agricultural Research Institute, Peradeniya (Breckenridge, 1980).

Minor Cereals and Millets

With the rapid advances that have been made in rice production, more attention is being concentrated on the improvement of maize (Hindagala 1980) finger millet (kurakkan) and wheat. Promising shortaged varieties of finger millet (2 1/2–3 months), higher yielding and more adaptable to the short

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rainfall periods and poorly irrigated areas of the dry zone, are in the final stages of testing prior to release.

Although wheat is the second most important cereal food next to rice, its production locally so far has been bedevilled by the climatic factor. Fortunately new tropicalized varieties are now being made available from the Maize and Wheat International Improvement Centre (Mexico) and other sources. Trials conducted at the Regional Research Centre, Bandarawela, and in other parts of the island augur well for introducing wheat as a supplementary cereal in the cropping calendar in the dry up-country and low-country dry zone (Fernando *et al* 1981).

The wheat improvement programme is co-ordinated by the Regional Research Centre, Bandarawela; the maize improvement programme by the Regional Research Centre, Maha Illuppallama; and the Finger Millet programme by the Regional Research Centre, Karadian Aru.

Grain Legumes

Pulse improvement has figured prominently in the research programme because this class of crops is the main source of low cost protein in the national diet. The first objectives were directed at improving the production potential of local varieties (Ariyaratne, 1980) and developing determinate to semi-determinate short-aged types of 2 1/2-3 months duration to suit the weather conditions obtaining in the dry zone, and to be used as sandwich or relay crops in rice lands. Outstanding varieties which have stood the test of time are Arlington and MI35 cowpea—the latter an acceptable substitute for dhal—MI 1 and Type 9 blackgram, and MI 4 greengram. Promising varieties of chickpea, turdhal and 'Lankakadala' (a chickpea like cowpea) are also under test. Pod borers and the Mung Yellow Virus are problems which are under investigation. Grain legumes research is co-ordinated by the Regional Research Centre, Maha Illuppallama.

Soybean. Perhaps the greatest success of the grain legume research programme has been the introduction and spread of adaptable soybean varieties such as PBI and Bossier (Fernando *et al* 1980; and de Zoysa *et al* 1980). The pioneering work done by the Soya Foods Research Centre at Peradeniya has helped to propagate the use of soya flour and milk both in domestic cuisine and in the commercial preparation of soya foods. The preparation of low-cost-high nutrient weaning mixtures and children's foods promises to remedy the nagging problem of malnutrition.

Seed Culture. Another breakthrough that augurs well for the future development of grain legumes is the local preparation of bacterial seed cultures (presently imported) at the Soya Research Centre, Peradeniya. These cultures

are prepared using a base of peat and filter mud. The soya development program is co-ordinated by the Deputy Director (Farms) Peradeniya.

Roots and Tubers

Potato. Potato production has made remarkable progress. Within the short space of two decades this crop has expanded to 4,800 ha, producing an annual output of 64,000 tons, which is adequate to meet local demands. The production of adequate planting material to sustain this program however remains a problem, because of land limitations above 1700 m where disease-free seed potato can be raised successfully. As a result, the greater part of our seed potato requirement is imported at a cost of Rs. 35 million annually. The cost of such imports may be expected to increase as the cultivated extent increases and world prices escalate.

While every endeavour will be made to expand the land area presently devoted to seed-potato production and increase the production therefrom, the most promising answer to this problem appears to be the local production of seed potato from true (botanical) seed. Research Officers at Bandarawela have already demonstrated that viable seed can be raised from popular varieties such as Desiree. Even the smallest first generation tubers raised from such seed have given economic yields of over 6 tons per acre. If true seed can be substituted for seed-potato-tubers there will be a considerable saving in the foreign exchange expended on seed potato imports, not to mention supplementary savings in the cost of transport, storage and storage losses.

Foreign exchange savings can also be earned by dispensing with the intensive use of chemical pesticides to control the late blight-disease which causes considerable crop losses in the up-country. The release of Krushi and Seetha, two late blight resistant varieties raised at the Sita Eliya Research Station, promises to alleviate this problem. Sita Eliya which co-ordinates the potato development program has about 7000 clones under test, several of which promise to produce higher yields than the currently recommended varieties, and which show excellent resistant qualities to Late Blight and Bacterial Wilt, the two most destructive diseases of the potato crop.

Root Crops. Improved varieties of cassava, e.g. MU51 and CMC84, and sweet potato, e.g. Cinchi, B1 and C26 have also been released for cultivation, while the search continues for higher yielding varieties amongst the dioscoreas, tannias and *Plectanthurus tuberosus* (innala). It is hoped to stabilise the production of energy foods by subsequent increases in root crops production through the spread of these new cultivars.

At the same time, the Central Agricultural Research Institute at Peradeniya, which co-ordinates the root crops development program, is pursuing

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its studies of seedling cassava to determine varieties with higher production potentials, higher starch and pulp contents and lower HCN to widen the germ plasm breeding base. Promising hybrid sweet potato varieties are also in the breeding pipe line.

Condiments

Dried chillies and shallot (red onion) are the chief condiments in local cuisine. The Regional Research Centre at Kilinochchi co-ordinates the chilli development programme. While we are almost self-sufficient in the production of dried chillies, with the MI-1 and MI-2 cultivars produced at Maha Illuppallama forming the backbone of the chillie industry, intensive cultivation over a long period of time specially in the Jaffna, Vavuniya, Mullaitivu and Trincomalee districts has caused serious pest and disease problems. The rising cost of fuel for pump irrigation and recent economic trends which have inflated the cost of shallot planting material are also factors which threaten to limit the cultivation of these crops in the future.

Accordingly research has directed its attention to alleviating these constraints by developing a more efficient crop protection programme, and producing shorter-aged chilli varieties which minimise the cost of production via reduced irrigation schedules, fertilizer applications, plant protection procedures and labour for harvesting and processing.

Answers have been found to the problems of nematode and spodoptera infestation of shallot. It is also very likely that a shorter-aged chilli cultivar, less expensive to cultivate, will be released shortly for general cultivation. This cultivar produces matching yields with MI 1 and MI 2 — the presently recommended cultivars.

True Seed. One of the greatest drawbacks to extension of the shallot production programme has been the high cost of planting material, amounting to 40 % of the crop budget. In this instance too the production of true seed of a certain variety known as Vedalan offers the promise of a more dynamic shallot production programme in the future.

Viable seed production of the Vedalan variety, which has the trifold advantage of producing excellent spring onions, edible flower stalks and big bulbs for the market, is possible upto 95% in the Kalpitiya Peninsula, where the soil and climatic conditions are favourable. Similar results have been obtained with "Poona Red" big onion-seed which is presently imported. A research station has accordingly been established at Kalpitiya to investigate and promote the onion seed production programme.

Oil Crops

The two most important oil crops are groundnut (peanut) and sesame (gingelly). Several improved varieties of groundnut have been recommended for cultivation, e.g. Uganda Erect, Red Spanish, A90, A92, M11, X14 and No. 45, along with M11, M12 and M13 gingelly.

Sunflower, safflower, lemon grass and castor are secondary oil crops which have been tested at the Regional Research Centre, Maha Illuppallama. Promising varieties are Spain 253416 and Turkey 15-1993 sunflower and Hazeera No. 1 castor. The oil crops development program is co-ordinated by the Regional Research Centre at Angunakolapelessa.

Fibre Crops

The Regional Research Centre, Angunakolapelessa, also co-ordinates the cotton research program. Although cotton has been cultivated for a long time, it still remains a *chena* crop in the Hambantota and Moneragala districts, mainly because of the very serious pest problem which necessitates intensive crop protection measures which are beyond the means of the average farmer. Despite the fact that more productive and shorter-aged cultivars have been developed, farmers continue to cultivate the old recommendation HC 101 which demands less attention and is more adapted to the *chena* system. Research Officers at Angunakolapelessa are therefore concentrating on developing a mixed cropping pattern with cotton as the chief crop to give farmers an additional income. They have also developed a more effective and less expensive crop protection program to control the Boll Worm, which is the most destructive pest.

Kenaf (*Hibiscus cannabinus*) is another fibre crop that has been developed as a substitute for jute fibre, which may be used in the manufacture of burlap bags, sack cloth, carpets, linoleum, backing and cordage. The introduced variety Cuba 2032 is the best that has been tested so far as yield is concerned, although there are several local varieties with comparable fibre quality.

Horticultural Crops

Fruits. Fruits and vegetables have not been neglected. Over the last three decades a number of local fruit crop selections and introductions have been recommended for cultivation. Noteworthy amongst these are the Embon banana, Bible sweet orange, Lemomime, Tahiti lime, Willard mango, Pollock and Purple Hybrid avocado, Kew and Mauritius pineapple, Malayan red, Malayan Yellow and selections of the Malwana rambutan, Saffaida and Alahabad guavas, Phenomenal strawberry, Yellow passionfruit and several varieties

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of grapes which are popularly cultivated. Some of these varieties have been selected for further propagation under a government fruit subsidy scheme now in operation.

Steps have also been taken to further improve the fruit industry by a Sri Lanka-FAO Horticulture Development Project. Under this project superior fruit varieties are being introduced and maintained in clone gardens, which will serve as nucleus breeding sources for the further multiplication and spread of these varieties through registered nurseries.

Rehabilitation work under the guidance of research officers at the Bandarawela Regional Research Centre is also going ahead in the Bibile area to resuscitate the orange plantations which were allowed to collapse through senility and neglect. Fruit producers are being encouraged to replant and to look after their plantations by the use of correct cultural practices which include fertilizer application, pruning and effective pest and disease control measures.

Vegetables. Vegetable breeding has been restricted mainly to indigenous varieties since exotic vegetables from temperate climates do not usually produce viable seed under tropical conditions. Outstanding examples of improved indigenous varieties are MI5 and MI7 Okra (bandakka) developed at Maha Illuppallama, L63 and L31 Okra (Kilinochchi) which are tolerably resistant to the mosaic virus disease; Katugastota Wilt Resistant, T146 and T89 tomato which are tolerant of the bacterial wilt disease; Peas Butter and Koku Bonchi pole beans (Bandarawela), Hawari me, Polon me, Murunga me, and Bushitao vegetable cowpeas; Jaffna Long and the Purple brinjal; a giant leaved variety of spinnach, bush varieties of gotukola (*Centrella asiatica*) and Kankun (*Ipomea aquatica*), Biraly radish, and selections in luffa, snake-gourd, bittergourd and cucumber.

Attempts are also being made to identify suitable varieties of exotic vegetables which can be made to produce viable seed under local climatic conditions. Some success has been achieved with a small headed cabbage called "Lankagova", Japanese Ball radish, and Renita an Indonesian carrot variety.

CROPPING SYSTEMS AND ADAPTIVE RESEARCH

It is not enough to test improved varieties and cultural techniques at the research stations. They have to be further tested in farmers' fields under realistic conditions of cultivation before they can be assessed as suitable. The wide gap that presently exists between research and farmer acceptance is the outcome of the lack of an intermediary transition process and the necessary infrastructure to service such a process. This deficiency could be met by selecting certain areas or villages as representative microcosms of a particular agroecological region for further testing, or by the establishment of Adaptive

Research Centres which provide for this necessity. Both avenues have been resorted to in an effort to create a more meaningful research atmosphere.

Cropping Systems Projects

Rice-based cropping systems were given priority. Three such projects were started at (1) Walagambahuwa—a typical small reservoir system in the minor irrigated rice lands of the dry zone. (2) Katupotha, a typical village area in the low-country intermediate zone of the Kurunegala District, dependent mainly on rainfall and (3) Idama in the up-country dry zone where similar precarious weather patterns exist. Cropping systems research is co-ordinated by the Regional Research Centre, Maha Illuppallama.

Walagambahuwa Project. In this project, officers of the Regional Research Centre at Maha Illuppallama demonstrated over a period of 5 years that small "tank" (reservoir) storage could be efficiently managed to take two successful crops in the Maha and Yala seasons if timely sowing was done, instead of the traditional practice of sowing late with the uncertainty of achieving a successful crop in the Maha Season and leaving the fields fallow in the Yala (Fernando *et al.*, 1980 and Upasena *et al.*, 1980).

Katupotha Project. Officers at the Regional Research Centre, Mankudura, have shown that while certain short-aged rice varieties can be grown successfully (according to improved cultural techniques) in the valleys and lower slopes of the landscape, the middle and upper slopes are more conducive to the cultivation of other food crops (Fernando *et al.*, 1980).

Idama Project. In the dry up-country rice cultivation is restricted to the Maha season when ample rainfall is available, and during the Yala season other high value cash crops such as potato and exotic vegetables are cultivated in the paddy fields. Research Officers at the Regional Research Centre Bandarawela, have indicated that if shorter-aged (3–3½ months) improved rice cultivars are substituted for the currently cultivated long-aged (4½–5 months) varieties they produce higher yields, and the saving in time permits subsequent food crops to be cultivated without exposure to unfavourable conditions (Fernando *et al.*, 1980).

Dry Farming Project. Highland cropping systems were also investigated. The Yoda Ela Project organised by the Regional Research Centre, Maha Illuppallama, demonstrated that a transition from the subsistence *chena* system of farming to a stabilized form of agriculture could be achieved with minimum tillage methods, and the inclusion of animal husbandry and the cultivation of semi-permanent money crops to tide over the dry period from June to September when no arable cropping is possible without irrigation (Fernando *et al.*, 1980.)

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The CIDA Dry Farming Project is carrying this experiment to its logical conclusion as an integrated farming system. Representatives of the IITA, in collaboration with the Regional Research Centre at Maha Illuppallama are also experimenting with advanced bush fallow systems which include avenue planting of fuel and green manure shrubs, together with live legume mulches and no-till methods of land preparation and planting which are directed to overcoming tillage problems and conserving soil fertility, two serious limitations to the transitional process from *chena* to a permanent system of upland farming in the dry zone.

Regosol Development. The sandy regosols found in the coastal regions from Kalpitiya through Mannar, the Jaffna Peninsula, Mullaitivu, Trincomalee and Batticaloa have all the year round supplies of subterranean water which can be more efficiently exploited to raise the cropping intensities of these areas. The Regional Research Centres at Makandura and Karadian Aru are actively involved in laying the foundation of such cropping systems via the cultivation of exotic vegetables, chillies, onions and potatoes.

Adaptive Research. Under the UN Agricultural Extension and Adaptive Research Project (1980-1984), provision has been made for at least one Adaptive Research Centre in each district. These centres will be required to "tailor" the research findings emanating from Regional Research Centres and Experimental Stations to suit farmer requirements.

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