

AGRICULTURAL RESEARCH: 1906 - 1981

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INTRODUCTION

It seems appropriate for this centennial edition of the *Tropical Agriculturist* that consideration and appreciation should be given to the contribution that agricultural research has made over the last hundred years towards the agrarian economy of Sri Lanka. At a time when issues of investment and returns to agricultural research, and the role and strength of national agricultural research programmes are under scrutiny and discussion, an holistic and historical view of an agricultural research programme in its totality is apposite, particularly given the very considerable achievements in Sri Lankan agricultural research. Within the scope of this paper it will not however be possible to develop fully this view or indeed explore more fully some of the more important thematic material relating to institutional, political, economic and scientific factors that have been instrumental in shaping the nature and the product of the agricultural research programme, although these matters will be touched on briefly. Emphasis will be given to bringing together the many strands of agricultural research activity that have been reviewed and commented on elsewhere (see for example Senadhira *et al* (1980), for a review of the rice programme; Panabokke (1968) for a review of research on soils and fertiliser; Wickremasinghe (1978) for research on entomology and Peiris (1957) for a review of plant pathology), The research activities of the commodity research institutes (tea, coconut and rubber) and research in animal health and production are specifically excluded from this discussion, the former because they have functioned outside the Department of Agriculture and the latter, which despite being under a division within the Department until 1978, lies outside the competence of the writer and besides has in many ways been historically separate from research in crops and soils.

What I will present here is very much my own personal view and is necessarily selective, very much in the same way as the recent Presidential awards to the plant breeders explicitly fail to fully recognise the important contribution of the plant pathologists and entomologists in the creation of new plant varieties. It is not the object of this paper though to provide a litany of achievements within individual subject areas and indeed that would very much miss the point concerning the nature of agricultural research which is more than simply research in biological, chemical and physical subjects as applied to agriculture. The issue is the way in which institutional, economic and social factors direct the research programme so that it is of relevance to the cultivator, a point which can be best illustrated by comparison between the

absolute success of Bg 11-11 and the relative failure of IR8 under Sri Lankan conditions. The issues that I will hope to address are therefore more concerned with the conceptual framework under which the research programme developed than with specific matters of scientific detail

INSTITUTIONAL FACTORS

The origins and early development of the Department of Agriculture are well documented (see for example Joachim, 1948). The Department developed from the Peradeniya Botanical gardens which had been established in 1822. Although agitation for a separate Department to be concerned with so called 'peasant' agriculture was instrumental in the establishment of the Department of Agriculture in 1912 the early activities and focus of the Department reflected the economic crop bias of the Botanical Gardens and were concerned mainly with plant and varietal distribution of species that on the one hand might be appropriate to peasant cultivation such as cotton, but yet were within the framework of a colonial plantation economy. Indeed the economic crop bias was a persistent theme of the Department of Agriculture activities until the 1940s, consistent with an administration policy of cheap importation of basic food requirements, both rice and wheat, to supplement the shortfall in domestic production. While the Second World War did much to focus attention on the importance of domestic food production, it would be untrue to say that this area had been entirely neglected; research on both rice and soils during the interwar period provided an important basis for subsequent research.

Development post-independence within the Department reflects to a certain extent the interests and aspirations of governments concerned with the problems of domestic production, predominantly of rice, although during the 60s and 70s less exclusively so as the so called 'subsidiary' crops received increasingly more attention. Government policy of increased rice production through strategies of investment in irrigation, dry zone settlement, guaranteed prices, credit and subsidised fertiliser with a certain degree of structural reform evolved over time and have been a consistent theme of agricultural policy which dates back to D. S. Senanayake in the 1930s. An increasing concern with detail of rice production during the 1950s and 60s, particularly as the foreign exchange reserves declined, are reflected in the institutional development of the Department of Agriculture: the creation of separate divisions of research, extension, farms and horticulture under Deputy Directors during the 1960s is one aspect of that: the theme of decentralisation on the basis of agro-ecological variation is another which was foreshadowed in the 1960s and developed explicitly in the Draft Agricultural Plan 1971-1977, and executed from the late 1970s. The important architectural contribution of Mahinda Silva over this period should be fully recognised, first in his capacity as Director of

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Agriculture 1963–1965 and later as principal author of the above plan and as Secretary to the Ministry of Agriculture 1970–1976.

One aspect that should be commented on specifically relates to the resources, both financial and manpower, that have been available to the research activity. A persistent comment by many observers (see, for example, Panabokke, 1968) has related to the minimal resources that have been used to support agricultural research within the Department, limiting both the range and coverage of research activities and most particularly the number of personnel available to carry them out. Indeed Moseman and Mclung's report (1974) indicated that only 42 research officers were working within the research division at that time and Senadhira's comment is probably indicative of the position during the preceding thirty years: 'but it is rather disheartening to find that the programme (as was reported in the previous symposium in 1966) yet does not have a single full time experienced and trained agronomist or entomologist or pathologist or physiologist. Hence only a few important lines are now handled' (Senadhira *et al*, 1980).

Further it is clear that the financial rewards for working within research were for many people insufficiently attractive to keep them and the comment by Seneviratne (1975), on the loss of six PhD qualified plant pathologists reflects the general position on the loss and turnover of highly qualified people from the research division to more financially rewarding positions elsewhere in the Civil Service or abroad. It is therefore remarkable what has been achieved on the basis of so few people.

Despite a somewhat widespread view that one of the many legacies of British colonialism, was the absence of trained and qualified nationals (see for example Barker and Herdt, 1982) the evidence from Sri Lanka belies this fact and one of the strengths of agricultural research in Sri Lanka has been the existence since the 1930s of highly qualified and dedicated scientific personnel who have shown a healthy regard for their own competence and a suitable discrimination of the various scientific approaches and products that have been on offer from overseas, particularly under aid-financed programmes.

1912 – 1947

This period spans the duration of the British administration upto independence; prior to the establishment of the Department of Agriculture the work of the Botanical Gardens had concentrated on plant introduction and acclimatisation, the testing and multiplication and distribution of economic species and only just prior to the establishment of the Department was the role of botany applied to agriculture developed with increasing concern over factors that caused variation in crop yields (such as soil, climate, pests and diseases). Although research on crops such as chillies, cotton, tobacco, green

gram and cowpeas was carried out during the first half of the twentieth century, there are two particular areas of research which are of particular interest and provided an essential base for subsequent work in these fields.

Under the influence of Frank Stockdale, the second Director of Agriculture (1916–1928) research into the collection and selection of improved rice varieties was initiated and during the 1920s under the botanists of this period, most notably L. Lord, pure line selections were initiated. A number of pure lines selections were made at this time such as Vellai Illankalayan, Pachchaperumal and Podiwi, and these latter two were to be subsequently used as parents for some of the most important rice varieties in the breeding programme of Batalagoda. It is perhaps worth noting that this example of the value and importance of earlier research in enabling subsequent progress to be made, illustrates an important methodological conundrum in defining the base line or starting point in attempting in crude economic terms to evaluate returns to investment in research in a particular subject of crop area. However, to put the research on pure line varieties into context, it should be pointed out that by 1920, the Japanese had exhausted the potential for pure line selection as a strategy for rice improvement and were embarking on their hybridisation programme.

The period before independence saw another development, namely the pioneering work of Joachim on soils which as the 1940's developed, essentially laid the framework and understanding for all subsequent work on soils and fertilisers. As Panabokke (1968) was to observe later 'the subsequent work (in this area) has changed the external form but not the basic content of Joachim's pioneering work and that this (change in external form) was largely a reflection of a changing conceptual framework for soils.' Joachim was to produce the first soil classification for Sri Lanka, based mainly on edaphic factors, identifying several of the major soil groups and their rough distribution. He also initiated the first experiments for evaluating fertilisers on different soil types and these long term fertiliser experiments laid the basic concepts of the fertiliser recommendations that were to be made over the next two decades.

1948 – 1981

As was indicated in the introduction, perhaps one of the most interesting and significant features of the research programme during this period has not been so much the actual products of the agricultural research, such as plant varieties, but the development of an overall conceptual framework that developed initially as an explanatory tool and more increasingly as a guiding influence over the activities and objectives of research.

The agro-ecological concept, which has essentially been that conceptual framework, has many elements to it and its historical derivation reflects a long line of thinking which was brought together, particularly under the

influence of E. Abeyratne, during the 1950s and subsequently by C.R. Panabokke. The notion of ecological variation and its influence on agricultural possibilities was in the mind of Stockdale in the early 1920s when he sought to provide some regionalisation of research activities and the eight agronomic divisions set up in 1946 were clearly based on some general recognition of agro-climatic zones although administrative considerations did not allow these to be put fully into practice. The conception, establishment and development of the dry zone research station at Maha Illuppallama did much to provide a scientific basis and understanding of the general idea of agro-economical variation. Maha Illuppallama's (MI) focus of dry land research owed much to Stockdale, and Rodrigo who as Director of Agriculture in 1938 toured India and was impressed by work being done there (on dry land agriculture) and felt that the dry zone of Sri Lanka offered similar possibilities.

Nevertheless the way in which the research programme at MI was conceived and carried out under the guidance of its first Director did much to provide an understanding of the interaction between soil and landscape and the influence that it would have on land use possibilities. Indeed Abeyratne's paper of 1956 (Abeyratne, 1956), probably one of the seminal papers in the history of Sri Lankan Agricultural Research and a subsequent address that he gave to the Ceylon Association for Advancement of Science in 1962 (Abeyratne, 1962), are remarkable for the fact that they do not describe new plant varieties or new techniques but they discuss the importance of land use classes, the significance of catenary sequences with specific soil moisture regimes, the relationship between drainage conditions and cropping possibilities, problems of soil fertility and its maintenance, the issue of rainfall and crop water requirements and recognise that 'the crux of the whole problem of management of dryland soils in the dry zone is the control of weeds'. Weed control and tillage remains a major problem for research but the overall framework and thrust of Abeyratne's approach which placed the research problem at the farmer and environment base level and not on an individual crop basis was one which clearly has had a major influence on many research workers and laid the basis for the contribution that the agro-ecological concept was to play, initially as an explanatory tool but subsequently as a guiding methodology. It would be wrong to claim this as an unique Sri Lankan achievement and unduly nationalistic to do so. Indeed Panabokke (1968) explicitly recognised, for example, the contribution of Milne's (1947) original work in Tanzania on soil-landscape relationships in tropical conditions and the derivation of the soil catena concept. Yet the way in which these ideas were adopted, modified and developed within the Sri Lankan context and the influence that they have had in stressing the importance of environmental specificity within a research context has been a fundamental strength of the Department's research programme.

The soils and soil survey work that grew out of the work at MI (Moorman and Panabokke, 1962), the development of the fertiliser recommendations and trials, (Panabokke, 1968), the studies on rainfall probability and confidence limits (Panabokke and Walgama 1974) and the emergence by the end of the 1960s of an agro-ecological map whereby twenty two distinct regions were identified by their unique soil and rainfall relationships, provided an important, coherent and explanatory tool that did much to provide for the rice breeders, for example, an understanding of the complexity of the rice growing environment and allowed them to elaborate the requirements and characteristics of rice varieties appropriate to the different soils and hydrological conditions (Gunawardena, 1974). The refinement of the agroecological concept to the microlevel initially in the wet zone (Panabokke and Somasiri, 1980) and developing now to the dry zone will have much value to future rice research and production.

The other major area of interest of the Department of Agriculture, not only within the research division but elsewhere in the extension, training and farm divisions has of course been centred around rice production. Indeed it is estimated that for the research division alone about 65% of the annual research budget has gone to rice research (D. Senadhira, personal communication). The very fact that from a position of only 45% self sufficiency in the late 1940s with a population of only 7 million people, that Sri Lanka is now nearly 95% self sufficient in its rice requirement with a population of 15 million, is a very considerable achievement. The contribution that research has made towards increased production is difficult to quantify but it is undoubtedly considerable.

By the early 1950s it was felt that further progress by pureline selections as a means of enhancing yield potential of rice varieties was not possible, largely because of the narrow genetic base of the Sri Lankan varieties. Pure line selection showed only a 10% yield increase over the unimproved varieties and they still suffered from many of the undesirable characters of the unimproved varieties, particularly lack of nitrogen responsiveness (although as Rodrigo pointed out (1966) this depended on how the nitrogen trial was carried out) and blast sensitivity. At the time (1959) it was felt by the International Rice Commission that indica varieties in general lacked the yield potential of the japonica varieties and an international indica-japonica hybridization programme was developed to transfer yield potential from japonica to the indica varieties. The problems of sterility in these crosses were however such that Dr. Chandraratna, chief botanist at the time, rejected this as an approach for Sri Lanka to follow and the subsequent Sri Lankan programme was to concentrate on hybridization within the indica group. Time has vindicated Dr. Chandraratna's view as improvement of the indica varieties has come about through crossing within the indica group; indeed such indica-japonica hybridizations

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that are carried out now, are mainly concerned with transferring into the japonica varieties desirable attributes of pest and disease resistance from the indica varieties (G. Khush, personal communication).

The early 1950s saw an important phase of importation and introduction of many indica varieties from all over Asia and testing and incorporation into the breeding programme, which was centred initially at MI but by 1952 established itself at Batalagoda. Fernando (1961) records that 726 varieties had been imported since 1948 although few made much direct impact in cultivators' fields, although Mas from Indonesia became quite popular before declining due to blast sensitivity.

However, 1957 saw the release of the variety H4, the first of a number of new varieties which collectively filled most of the important age classes that had been identified and these H varieties are now known as the old improved varieties (OIV). H4 was particularly successful in some areas occupying over 80% of the rice lands but it had defects which the breeders were aware of, particularly in its tendency to lodge under conditions of high fertility, and the breeding programme that developed out of the H varieties had as a primary objective yield stability or lodging resistance. It is difficult from the vantage point of twenty years later to disentangle the nature and sources of information available to Sri Lankan rice breeders at the onset of the 1960s. History records the development of Taichung Native 1 in Taiwan in 1956, the establishment of the International Rice Research Institute (IRRI) and the development of its rice breeding programme in the early 1960s and the fact that H. Weeraratne, breeder of the H4 variety, was trained in the Philippines between 60-63 and was well aware of the IRRI programme. It seems probable that there was an awareness of the importance of plant stature and its relationship to yield although utilisation and testing of the dwarf plant material does not appear to have taken place before Weeraratne brought it back with him from the Philippines at the end of his training. Weeraratne's disappointment with the performance of this dwarf stock, (Dee-gee-wo-gee and TN1) is recorded by Peiris (personal communication), a disappointment based on observation of its poor growth and yield under actual cultivation conditions in farmers' fields and its susceptibility to blast. Indeed this experience was important in framing the objectives of the Sri Lankan plant breeders at the time and as Weeraratne was to comment in the 1966 symposium on Rice Research and Production:

'It should be clearly understood that super-imposition of a delicate, improved plant type highly responsive to fertilisers under unimproved cultivation will be practically suicidal, Under low fertility levels and poor cultural standards, the performance of the improved type is bound to be inferior to the undesirable type' (Weeraratne, 1966).

This strong awareness of the reality of cultivation conditions is a notable feature of the whole rice programme in this decade and it clearly informed the strategy behind the development of the Coordinated Rice Varietal Trials (CRVT).

This approach contrasts strongly with the IRRI breeding, testing and evaluation programme of IR8, which was clearly concerned with maximum potential under ideal conditions and it is a matter of record that those within the research division who opposed on scientific grounds the controversial introduction of IR8 to Sri Lanka were vindicated. The somewhat intermediate habit of BG 11-11, effective in suppression and competition against weeds contrasted strongly with the dwarf stature of IR8 which under many Sri Lankan conditions did not reach more than 45-50cm. It is one of the quirks of research that the breeding grounds for the Bg varieties have been the phosphate poor sandy soils of Batalagoda while that of the IR varieties has been the nitrogen rich alluvial plains of Los Banos. This factor alone must have had some effect on the comparative ability of the two breeding materials to grow and yield under poor conditions.

The CRVT programme was not without its flaws, most importantly the fact that varieties from the poorly drained soils of Bombuwela, while excelling at Bombuwela itself, fared rather less well at other national sites and on a national basis rarely achieved selection. The escape of BW78 and the subsequent demand for it by cultivators in the low country wet zone, led ultimately to the development of the district coordinated variety trials where varieties are now evaluated and selected for the range of conditions within the district, so that district specific recommendations can be made.

The subsequent objectives and further development and release of the Bg family of rice varieties, laid on the groundwork of the 1960s breeding programme and the CRVT, is well documented by Senadhira *et al* (1980). Objectives of yield stability and potential in all age classes have been met, along with the demanding problems of disease and pest resistance and a measure of the success of these varieties is that now nearly 60% of the rice lands are occupied by the NIV, 23% by the OIV, with the balance in the least favourable environments being occupied by pureline selections or unimproved varieties.

CONCLUSIONS

The "Daily News" reported that the International Rice Research Institute had selected two varieties of paddy from Sri Lanka, Bg 367-4 and Bg 367-7, as the best high yielding varieties in South East Asia and Africa. They were selected after extensive trials carried out in East, South East and South West Asia and also in North Africa and Latin America. The variety Bg 90-2 was also used as a check variety at the International Institute for Tropical Agriculture in Nigeria and it is evident therefore that the Sri Lankan

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research effort has had an impact not only at the national level, and the contribution that it has made internationally extends beyond rice varieties to subjects such as the identification of biotypes of *Pseudomonas solanacearum* and the development of *in vitro* cultural conditions for gall midge. Indeed given the ecological diversity of Sri Lanka and the excellent field laboratory that Sri Lanka is in some respects, it would have been surprising had the programme failed to develop the way that it has.

Yet the salient question concerns the contribution that the research programme has made at the level on the individual farmer. As the Draft Agricultural Development Plan 1971-1977 stressed 'the salient criteria for agricultural research (is) farm incomes'. At a general level it is easy to identify the products and achievements of agricultural research: new plant varieties, disease resistance, pest management, fertiliser recommendations and new cropping systems; the impact that these have had and will have on farm incomes in agro-ecologically specific regions is far less clear.

The yield potential of most Bg varieties is 200 bu/ac although, despite marked regional variations in this figure, the national average remains stubbornly low at 60 bu/ac. The challenge for agricultural research in the decades to come will be to move even more to the farm level, to understand by study and analysis rather than by prescription the nature of the constraints within the farming system. Breeding new higher yielding varieties alone will not raise average yields: understanding the impact of resource, labour and financial constraints and designing research strategies most appropriate to these will: but this will be an even more exacting task, yet one, which given its historical record, should not daunt agricultural research in Sri Lanka.

ACKNOWLEDGEMENTS

It is perhaps somewhat insidious to single out particular individuals for specific recognition since I have drawn on the time, information and ideas of so many people, but particular mention and gratitude should be expressed to Dr. E. Abeyratne, Dr. C. R. Panabokke, Dr. G. W. E. Fernando, Dr. L. Peiris, P. Jinendradasa, A. T. M. Silva, Dr. Senadhira and Dr. I. Gunawardena.

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