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Protecting diversity in rice: Rapid clonal multiplication of rice seed

1. GENERAL INFORMATION

1.1 Title of practice or experience

Protecting diversity in rice: Rapid clonal multiplication of rice seed

1.2 Category of practice/experience and brief description

Rice is the most important foodgrain crop of Asia. It is also the most threatened by germplasm loss. Thousands of rice varieties and cultivars have been forever lost to humankind in the wake of the uncritical and rushed introduction of a few short-stemmed (dwarf) hybrid varieties over the last three decades. The spread of the few hybrid varieties, largely from the International Rice Research Institute (IRRI), has also resulted in an alarming situation of genetic uniformity in rice paddies all over Asia.

One rice scientist who saw the emerging threat to biodiversity was the late Dr. R.H. Richharia. He set out to provide a remarkable solution to conserving endangered rice cultivars: a seed multiplication technique that is not only effective but is so simple it can be easily acquired by rice farmers. The technique of rapid clonal multiplication of rice seed enables any farmer to effectively proliferate even a single seed of rice into thousands within the space of a single season. The technique is particularly useful for rapid multiplication of endangered varieties of which only a few seeds may be available. The method will work even if one has a single healthy grain of rice. Using the method, groups and communities working with traditional varieties can multiply these for propagation at no extra expense and without having to rely upon centralised research institutes.

*1.3 Name of person or institution responsible for the practice **or** experience*

The late Dr. R.H. Richharia
Kaluram Khandu Bhagat

Academy of Development Science
Indian Society for Rural Gene Banks

1.4 Name and position of key or relevant persons or officials involved

Rajeev Khedkar, Secretary, Academy of Development Science
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1.6 Name of person and/or institution conducting the research

Claude Alvares, Editor, Other India Press

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2. THE PROBLEM OR SITUATION BEING ADDRESSED BY THE PRACTICE/INNOVATIVE EXPERIENCE

In many of the rice fields of Asia, from the Philippines to India, farmers are expressing a desire to replace the modern varieties of rice with the varieties they were planting a few decades ago. This conversion has not come about overnight: farmers have gradually (and sometimes even grudgingly) discovered that the so-called "high-yielding" varieties (HYVs) introduced by IRRI and a few national institutes of research as well are seriously plagued with chronic genetic and environmental problems for which no long-term remedy exists.

These chronic problems include the susceptibility of these modern varieties to an entire range of unexpected pests and viruses which often devastate entire areas, leaving the farmer with neither food nor income and sometimes in debt. No sustainable, long-term measure for dealing with these problems of plant disease and insect attack is available except routine advice from scientists and companies to farmers to continue spraying ever more toxic mixtures on paddies.

The general confidence that rice scientists may be able to solve these problems seems to have been drastically eroded over the past decade.

Many of the modern varieties have also reached a productivity plateau: they require more and more fertiliser merely to maintain their present output levels. Productivity is also going down simply because the soil has been mined of all its trace elements and has little left over to feed new plants. The "high-yielding" dwarf varieties are also known sometimes as "high-response" varieties in view of their enormous appetite for chemical fertilisers. And fertiliser prices are going up everywhere in the South, as they are based on imported feed stock in most cases.

The scenario is hardly a desirable one.

There is an additional aspect: it is now acknowledged that the modern varieties cannot survive any longer without the infusion of genes from the older varieties and from wild relatives. Most of the modern varieties have, in fact, survived on the genetic crutches provided by the traditional varieties and their more resistant genes.

However, as more and more "successful" modern varieties are propagated, more of the traditional varieties go out of use and become extinct. If this continues to happen, the future of the modern varieties themselves, on which millions of farmers have been made dependent, would be profoundly at stake.

One of the solutions for the conservation of rice germplasm has been the setting up of centralised gene banks in which indigenous or traditional rice varieties and cultivars are maintained under special conditions.

However, the reported survival rate of seed maintained in such refrigerated gene banks is hardly impressive. For this reason, concerned scientists have proposed that rice germplasm should also be maintained *in situ*, in the fields of farmers.

As farmers seek more and more traditional varieties, however, they are bound to encounter problems of seed scarcity. This is because the established rice research institutes are not geared towards addressing this aspect of the problem, that is, towards the multiplication of traditional seed or even towards supplying farmers with the seed from their gene banks. In some areas, only a few seeds of a particular variety may be available. The variety in question may have certain desirable traits which it might be useful to propagate among farmers. How does one rapidly multiply such seed without relying on expensive, privately run research institutes or, worse, seed multinationals?

It is in such circumstances that Dr. R.H. Richharia's technique of rapid clonal propagation of rice produces stunning results. The technique enables immediate salvage of those rice varieties of which there are very few seeds, or not even one single seed, available. Thus, it is a great tool available to farming communities and gene banks specialising in rice to enable them to rapidly increase their stock of endangered rice seeds.

Using the clonal propagation technology, one can easily generate from a single good seed, and that too within 10 months, up to 4,000 kg of pure, productive rice seeds of the same variety. With this quantity, 80-100 acres can be cultivated in the following season with the same variety. This makes expensive duplication of rice seed from central sources or laboratories entirely unnecessary and redundant.

Productivity of rice in India and Asia generally has stagnated with the introduction of new dwarf varieties via IRRI and other rice research centres: this is now acknowledged even by IRRI itself in its own publications and scientific papers.

The present methods of rice research at such institutes involve identification of rice cultivars with desirable characteristics, incorporation of desired genes, and their multiplication in laboratories for distribution to farmers. The institutional drawback is that the focus remains on a few varieties. Once these are identified or selected, these are propagated at the expense of those being grown by farmers in their fields. The model of rice research therefore precludes the existence of an alternative system in which farmers themselves select good varieties from their own eco-region and then maintain, sell or otherwise exchange the seeds of such varieties among themselves. Dr. Richharia's clonal propagation technology was invented to circumvent this problem: it teaches farmers how to raise several kilograms of rice from a single seed and that too within a single season.

In fact, it enables an alternative rice research system to develop in which progressive farmers are able to multiply good seed for distribution to other farmers and to thus contribute towards the conservation and development of such varieties. At present, they play no such role since all research into rice and rice varieties is now effectively monopolised by rice scientists.

An additional feature of rice propagated by the vegetative method is that the yields from such rice plants have been confirmed to be much higher than the yields from seed to seed crops. This is an important consideration in adopting the technology on a large scale in the paddies of Asia.

3. DESCRIPTION OF THE PRACTICE/INNOVATIVE EXPERIENCE AND ITS MAIN FEATURES

The technique of clonal propagation of rice depends, in the ultimate analysis, on the availability of at least one good seed of the variety that needs to be conserved or propagated. Despite several decades of the Green Revolution and of official dissemination and sponsorship of **HYVs,** several farmers continue to plant their older seeds and to harvest them.

Those wanting a choice of such indigenous seeds should tour their regions and collect a handful of the seeds of such varieties and catalogue their specific characteristics after a discussion with the farmers from whom they are taking them.

The available seed or seeds are grown in a mud pot or in a small nursery bed. The bed material must be prepared with good soil and manure. Approximately six to eight seeds should be planted in case one is using a mud pot. Larger quantities should be sown in nursery beds but thinly planted.

Water availability is important. Hence the seeds must be planted at the commencement of the monsoon or, if water supply is available, during the month of February.

As the rice plant grows, it begins to throw out tillers within 10-12 days. After approximately 20 days, the tillers would be fairly strong and able to stand on their own. The plant is now carefully dug up, without damaging the roots.

The top of the plant, that is, the tapering portion of the leaves, is now removed by hand or lopped off. The roots are then washed and the tillers separated from each other by using either a blade or the thumbnail. The arrangement of the tiller formation is linear, allowing for easy separation. Each of the tillers is a clone of the mother plant and will have all the genetic characteristics of the mother plant.

The separated tiller clones are now planted each by itself in a well-watered nursery bed.

After they are established, the individual tillers will in turn send out fresh tillers. Thereafter, the process of separation and planting of these tillers is repeated. Through this method, the plant population multiplies by leaps and bounds every 20 days.

This process can be repeated till an adequate population of plants has been created, after which the plants are allowed to reach the maximum veg-

Diagram 1: Separation of Tillers

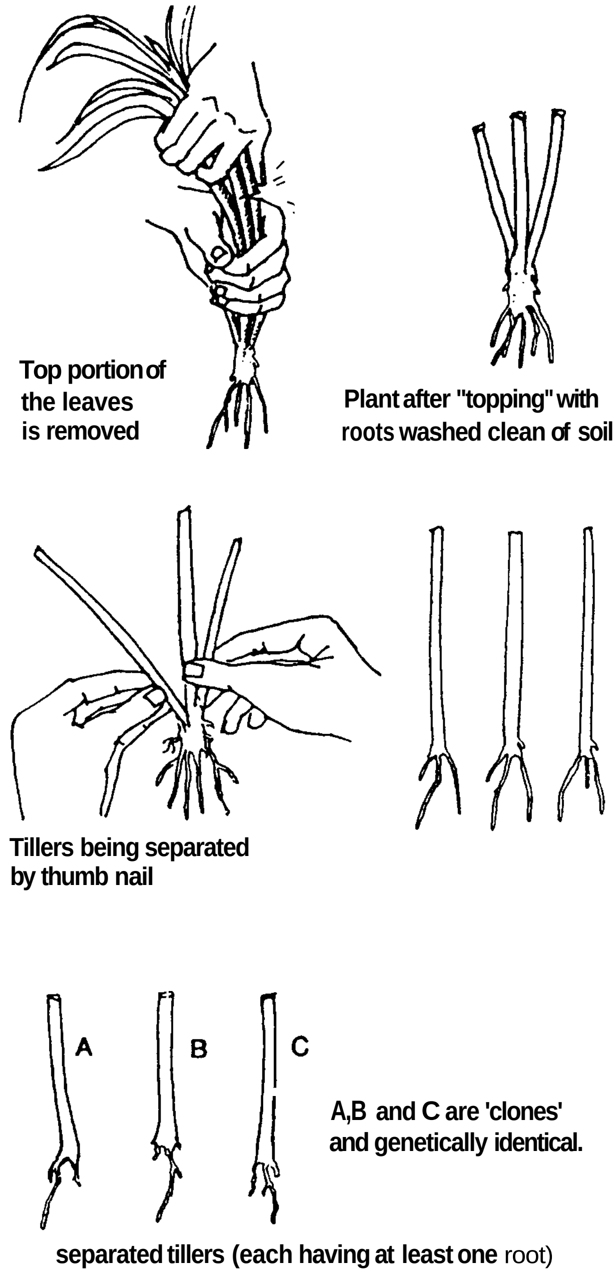
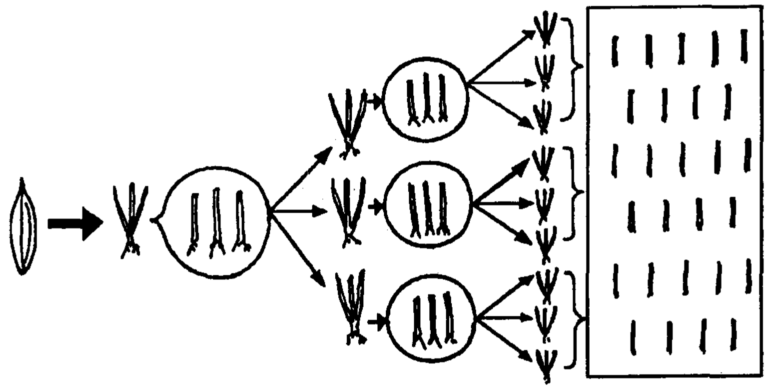


Diagram 2: Repeat the cloning



Note:
For simplicity, the number of tillers per plant has been taken as 3. However, in actual practice, cloning may be done when there *are* 2 or 4 or *more* tillers, depending *on* the situation.

etative growth stage when they are allowed to seed as normal.

There are two important aspects to clonal (or vegetative) propagation of rice to be noted.

The first is that clones can be generated from numerous sources and not just from seed. Dr. Richharia produced clones from all kinds of material. For instance, he experimented with tillers that sprouted from stubble left over in the fields after rice had been harvested. He also worked with rice that had been transplanted: immediately after the rice plants had been stabilised, he cloned them again, increasing the plant population by 40%.

The second aspect of clonal propagation is the impact on yields. Dr. Richharia and his research teams found that grain yields and straw from cloned plants were invariably and significantly higher than grain yields and straw from crops raised directly from seed.

4. DESCRIPTION OF THE INSTITUTION RESPONSIBLE AND ITS ORGANISATIONAL ASPECTS

The Academy of Development Science **(ADS)** is a registered non-governmental organisation (NGO) based in a tribal area near Karjat, Raigad District, Maharashtra State. Mr. Kaluram Khandu Bhagat from ADS conducted detailed trials on clonal propagation of rice varieties under the personal supervision of Dr. Richharia (while he was still alive).

The Academy of Development Science, as a people-oriented science and technology organisation, is primarily concerned with problems faced by village communities, particularly the tribals, the landless, and small and marginal farmers.

Conservation of crop genetic resources is one of the thrust areas of ADS. Dr. Richharia initiated the conservation project at ADS in 1988 and was closely involved with the developments at each and every stage of the project. The project took concrete shape by 1994-95 and Dr. Richharia was extremely proud of the achievements. He passed away in 1996. Dr. Richharia continues to be a source of inspiration for the ADS Conservation project.

As part of this programme, ADS is looking at ways and means to restore the genetic diversity of rice in the Konkan region. It has established a community genebank of rice cultivars for this region and it is actively involved in seed multiplication and distribution. The genebank has a collection of over 350 traditional rice varieties from the Konkan region. ADS is also exploring possibilities of improving the performance of traditional cultivars through application of technologies like clonal propagation and hybridisation. In hybridisation, the focus is on exploiting the hybrid vigour of plants by crossing different eco-types of the same genotype.

ADS also organises a number of training/awareness programmes for NGOs and farmers.

The Indian Society for Rural Gene Banks (ISRGB), which is an autonomous entity within ADS, is involved in promoting and setting up decentralised gene banks in rural areas.

5. PROBLEMS OR OBSTACLES ENCOUNTERED AND HOW THEY WERE OVERCOME

The impact of using the clonal propagation technique on paddy cultivation was far more impressive when Dr. Richharia was heading the rice research set-up in India than it is now. Today, the use of the technique has been restricted to a few areas and that too within the non-official sector. This is largely due to the fact that the modern system of rice research is fairly centralised and has no capacity to patronise or endorse an alternative, decentralised system of research and development.

Rice research stations admit that the technique invented by Dr. Richharia can be profitably used to enhance seed production from a single healthy seed without any extra cost and without dependency on expensive equipment.

However, rice scientists are wary of the technique because it might render their work, now intimately connected with the use of chemicals and genetic manipulation, redundant in the long run.

In fact, as the technique demonstrates, rice research need no longer remain a monopoly in the hands of a few rice scientists working in agricultural rice stations. It can become a farm-to-farm experiment conducted by thousands of farmers in their own fields working with their own indigenous varieties. This could herald a potential revolution in rice production even as it enables conservation of rice varieties on a qualitatively superior footing than hitherto.

Besides conventional rice scientists and rice research institutes, other obstacles in the way of widespread dissemination of the clonal propagation technique include the seed and fertiliser corporations. Dr. Richharia insisted throughout his life that several indigenous HYVs of rice could be used as the basis for a new rice revolution based on clonal (or vegetative) propagation. He proved that such propagation techniques actually enabled production to increase dramatically without any additional inputs in the form of fertiliser. The method of clonal propagation actually liberated the farmer from seed companies or seed research centres. This has been extremely difficult for the rice research community, which has a vested interest in its own perpetuation, to accept with equanimity and grace.

6. EFFECTS OF THE PRACTICE/INNOVATIVE EXPERIENCE

During the time when he was Director of India's premier rice research institute based in Cuttack, Orissa, Dr. Richharia worked extensively with farmers to disseminate the clonal method of propagating rice. In certain circumstances, his research workers even learned to distribute rice clones (tillers) in place of seeds. Once certain indigenous, high-yielding seeds were identified, the research teams were able to rapidly disseminate clones **of** such varieties among farmers in the state.

Clonal propagation was eventually taken up in several states of India, including Bihar, Andhra Pradesh, Mysore, Kerala and West Bengal.

7. SUITABILITY AND POSSIBILITY FOR UPSCALING

Upscaling is possible, as the technique can be applied in small nurseries or in large farms with equal ease, provided labour is available.

However, it must be remembered that the technique is limited to production and multiplication of rice seed only due to the peculiar perennating nature of the rice plant or its unique ability to multiply its tillers indefinitely. The technique therefore cannot be used on other cereal crops.

8. SIGNIFICANCE FOR (AND IMPACT ON) POLICY-MAKING

Government policies of rice breeding are capital-intensive and equipment-dependent and eventually face the problem of how to transfer such techniques to the farmers. At present, only the results of plant breeding, that is, seeds, are distributed to farmers, with the important skills of seed multiplication and breeding retained by the rice scientists.

Dr. Richharia's techniques enable every rice farmer to become a rice scientist and to use his field as a fertile laboratory for maintaining rice germplasm and as a decentralised source of production of those seeds that have desired characteristics.

In addition, the technique **is** absolutely free and labour-intensive. It does not require heavy capital investments, machinery nor buildings. If governments find such systems desirable, it would be easy to adopt them for widespread use. Rice scientists, in that case, could apply themselves to more **pro**ductive research.

9. POSSIBILITY AND SCOPE OF TRANSFERRING TO OTHER COMMUNITIES OR COUNTRIES

The clonal propagation technique is simple and can be easily applied in all those areas where the problems with rice cultivation discussed above are faced. The technique is not location-specific but rice-specific.

10. OTHER COMMENTS

A simple manual on the rapid clonal multiplication **of** rice seed, prepared under the direction of Dr. Richharia and published by the Other India Press, is available. The manual explains step by step what must be done in carrying out the multiplication process. It is accompanied by appropriate illustrations. But the best detailed work on clonal propagation is Dr. Richharia's standard text: ***Rice*** *in Abundance* ***for*** *All Times Through Rice Clones*. This book has been published by the Sri Aurobindo Rice Research Centre, Aurobindo Ashram, Pondicheny 605 002, India.