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# HIGH YIELDING VARIETIES OF RICE - A STUDY OF SELECTED AREAS IN KERALA

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## I. High Yielding Varieties of Rice in Kerala

(i) Before we get down to the findings of our field study, we shall attempt to present an overview of the performance of HYVs in Kerala since their introduction here. As of 1976-77, the proportion of area under HYVs of rice in Kerala, viz. 30.9 per cent, was less than the all-India average of 34.6 percent, and far below that in Tamil Nadu (92.3), Punjab (85.9), Haryana (57.4), Jammu & Kashmir (75.7), Andhra Pradesh (55.5), etc.[1/] These estimates are not strictly comparable. In Kerala, we understand, the area under HYVs is estimated on the basis of actual verification in the field by the Investigators under the Bureau of Economics and Statistics; in other States, the estimates are derived by an indirect method based on the quantum of seeds distributed, and an assumed seed-area ratio and a rate of natural spread over time. Not that the former method is free from errors; but the latter is sure to contain a wide and uncertain margin of error all along the line. Thus, in North Arcot District, the overall official estimate of the proportion of area under HYVs in 1972-73 exceeded the estimate based on Survey data by a factor of three.[2/] If this be true, the difference between Kerala and other States may not be all that significant. Be that as it may, it is significant that HYVs have not spread to nearly two-thirds of the rice area in Kerala by 1978-79. (Table 1).

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1/ Fertilizer Association of India, Fertilizer Statistics, 1977-78, New Delhi, 1978, Table 9.08, pp.II-90-92.

2/ B. Najamma Chinnappa, "Adoption of the new technology in North Arcot District", in B.H. Farmer (ed.), Green Revolution? Cambridge Commonwealth Series, Macmillan, London, 197 p.96.

# HIGH YIELDING VARIETIES OF RICE - A STUDY OF SELECTED AREAS IN KERALA

## Introduction

By 1978-79, the area sown to high yileding varieties (HYVs) of rice in Kerala came to about 35 per cent. The spread of the new varieties would appear to be low, given the great claims made for them, and the comparatively high level of knowledge, awareness and receiptivity of farmers in Kerala. Or, is it that the performance of the so-called miracle seeds here is not as good as claimed? Quite a few studies have gone into the performance of the new rice in other parts of India. The present paper incorporates part of the findings of an enquiry into the socio-economic factors underlying the adoption of HYVs. Palghat and Kuttanad, the traditional rice bowls of Kerala were selected for the study. Being more favourably endowed, the rate of adoption of HYVs should also be higher in these two regions.

In Section I we present an overview of the trend and extent of adoption of HYVs, and the level and stability of their yield in Kerala. Section II gives the salient features of the study areas. The rate of adoption of HYVs by the sample cultivators is discussed in Section III. The performance of the new seed varieties among the sample holdings is examined in Section IV. The various factors which have a bearing on the performance of HYVs are considered in Section V.

Table 1: Area Under HYVs in Kerala, Seasonwise

Area in Hectares

| Year | Virippu | | | Mundakan | | | Punja | | | All Seasons Combined | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All varieties | HYVs | Percent under HYVs | All varieties | HYVs | Percent under HYVs | All varieties | HYVs | Percent under HYVs | All varieties | HYVs | Percent under HYVs |
| 1969-70 | 393747 | 39840 | 10.11 | 382171 | 49782 | 13.03 | 98141 | 46512 | 47.39 | 874059 | 136134 | 15.57 |
| 1970-71 | 394798 | 58036 | 14.70 | 381971 | 48143 | 12.60 | 98061 | 53038 | 54.09 | 874833 | 159217 | 18.20 |
| 1971-72 | 395296 | 68539 | 17.33 | 381971 | 31876 | 8.34 | 97888 | 67444 | 68.90 | 875157 | 167859 | 19.18 |
| 1972-73 | 391900 | 94291 | 24.06 | 312181 | 55033 | 14.40 | 99623 | 60054 | 60.28 | 873704 | 209378 | 23.96 |
| 1973-74 | 392765 | 125298 | 31.90 | 380980 | 57076 | 14.98 | 100930 | 65904 | 65.30 | 874375 | 248272 | 28.38 |
| 1974-75 | 394927 | 77537 | 19.63 | 384836 | 50988 | 13.25 | 101703 | 39128 | 38.47 | 881466 | 167653 | 19.02 |
| 1975-76 | 375043 | 98531 | 26.27 | 396392 | 62173 | 15.68 | 104587 | 69357 | 66.35 | 876022 | 230101 | 26.27 |
| 1976-77 | 363822 | 115764 | 31.82 | 381678 | 74803 | 19.60 | 108874 | 73407 | 67.42 | 854374 | 263974 | 30.90 |
| 1977-78 | 365111 | 142129 | 38.93 | 370859 | 89565 | 24.15 | 104404 | 61599 | 59.00 | 840374 | 293293 | 34.90 |
| 1978-79 | 346827 | 144909 | 41.78 | 345720 | 77909 | 22.53 | 106684 | 56416 | 52.88 | 799230 | 279234 | 34.94 |

Source: Bureau of Economics and Statistics, Kerala Economic Review (Annual Series)

(ii) The rate of spread of HYVs has been the greatest during Punja (summer) season followed by Virippu (Autumn) and Mundakan (Winter) seasons.

Elsewhere in India also the rate of progress of HYVs has been better during the rabi, the season corresponding to Punja in Kerala.* This is generally attributed to the more favourable environmental conditions obtained during the rabi such as controlled irrigation and drainage, temperature, solar radiation, etc. which draw out more fully the genetic potentialities of the new seed varieties. Reviewing the progress of HYVs in Andhra Pradesh, Parthasarathy and Prasad point out that the inter-seasonal differences in the yields of local varieties, rather than between HYVs and locals, together with higher price of rice during rabi account for the greater spread of HYVs during than in Kharif. According to the data relating to the two districts 1968-69, the kharif yield of IR8 "are not found to be less than the rabi yields." 3/ Or rather, the Rabi yields of IR8 are lower than kharif yield. This is an unusual phenomenon.

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3/ G. Parthasarathi and D.S. Prasad, "Season-wise Progress of High-yielding Varieties in Andhra Pradesh - Role of Economic Variables", Economic and Political Weekly, Review of Agriculture, Vol.VI, No.39, September 1971.

* Broadly the sowing and harvesting periods of the three rice seasons in Kerala are as follows:

| | Sowing | Harvesting |
|---|---|---|
| Virippu (Autumn) | April - May | September - October |
| Mundakan (Winter) | September-October | December - January |
| Punja (Summer) | December - January | April - May |

Bureau of Economics and Statistics, Season and Crop Report for Kerala State, 1971-72, Government of Kerala, Trivandrum, 1974, p.27. Needless to say, there would be changes in the timing of sowing and harvesting from region to region, and from year to year, as governed by rainfall and other environmental factors. The sowing and harvesting seasons for Punja in Kuttanad are October-November, and January-February respectively.

Thus,in Kerala, for the period 1969-70 to 1977-78, the average yield rate of HYVs during Punja came to 2075 kg. per hectare, as against 1751 kg. for Virippu and 1695 kg. for Mundakan crop (Table 2). The lower yield rate of HYVs during Virippu and Mundakan due to certain environmental constraints and the higher costs of production imposed by these constraints could be the factors inhibiting the rapid spread of HYVs in these seasons. Further, the range of interseasonal variation in yield is less for local varieties, viz., 1387 to 1459 kg. per hectare, than for HYVs which is between 1695 and 2075 kgs. per hectare.* Therefore, couldn't it as well be argued that the inter-seasonal differences in the yield of HYVs rather than that of local varieties account for the differential spread of new varieties, one wonders. The higher price during summer - which together with a larger yield given a higher gross or net income - is understandable, since area under, and production of, rice in the country during summer, is far less than that during the other seasons. In Kerala, area under Punja comes to about 12 per cent of the total, and the Punja crop fetches a higher price.

(iii) We also notice considerable inter-district variations in the rate of adoption of HYVs. The proportion of area under HYVs in the three seasons together ranged from 11 percent in Cannanore to a little over 49 per cent in Kottayam district over the period 1969-70 to 1976-77

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*The yield rate of local varieties is found to be lower during Punja. The reason for this is that during the normal Punja season, only a short-duration variety like PTB10 is cultivated while in Virippu and Mundakan seasons, medium and long duration varieties are grown. And the yield of a short duration variety even grown during the Punja season will not come to the level of a long duration or medium duration variety grown in the other two seasons.

Table 2: Yield rates of rice in Kerala

Rice: kg./ha.

| Year | Virippu | | Mundakan | | Punja | | All Seasons | | Ratio of yield of HYV to LV (all seasons) |
|---|---|---|---|---|---|---|---|---|---|
| | HYVs | LVs | HYVs | LVs | HYVs | LVs | HYVs | LVs | |
| 1969-70 | 1549 | 1290 | 1603 | 1344 | 2220 | 1455 | 1790 | 1330 | 135 % |
| 1970-71 | 1644 | 1317 | 1564 | 1402 | 2346 | 1505 | 1354 | 1401 | 132 |
| 1971-72 | 2092 | 2239 | 1803 | 1541 | 2374 | 1390 | 2150 | 1857 | 116 |
| 1972-73 | 1537 | 1449 | 2035 | 1520 | 2124 | 1602 | 1836 | 1453 | 123 |
| 1973-74 | 1826 | 1409 | 1328 | 1334 | 1508 | 1266 | 1627 | 1362 | 119 |
| 1974-75 | 1664 | 1276 | 1644 | 1553 | 2054 | 1851 | 1750 | 1456 | 121 |
| 1975-76 | 1802 | 1349 | 1593 | 1453 | 2139 | 1120 | 1825 | 1411 | 129 |
| 1976-77 | 1605 | 1217 | 1825 | 1470 | 2012 | 872 | 1752 | 1328 | 132 |
| 1977-78 | 2024 | 1184 | 1806 | 1396 | 1997 | 1416 | 1960 | 1311 | 150 |
| 1960-70 to 1977-78 | 1751 | 1414 | 1695 | 1439 | 2075 | 1387 | 1841 | 1439 | 128 |

Source: Bureau of Economics and Statistics, Kerala Economic Review, Govt. of Kerala (Annual series).

taken as a whole (Table 3). By and large, Kottayam and Alleppey are in the lead, while the northern-most and southern-most districts lag behind.

(iv) The spread of HYVs is characterised by considerable fluctuations from year to year. The coefficient of variation in the adoption rates over the period 1969-78, for the three seasons combined, ranges from about 15 per cent to 79 per cent. In fact the amplitude of fluctuations in the area under HYVs in various districts, and during each season, is greater, and naturally so. However, it is difficult to discern any consistent pattern in the fluctuations in area under HYVs between seasons or regions differentiated by the overall adoption rates.(Table 3).

(v) What are the prospects of further spread of HYVs? It is difficult to make a conjecture one way or the other. However, we should examine some trends which may have a bearing on this question. Over the period 1969-74, area under HYVs increased by 112 thousand hectares, from 15.6 per cent to 28.4 per cent of the total area under rice; but the additional area gained during 1974-78 came to a little over 45 thousand hectares. During 1978-79, area under HYVs actually dropped by 14 thousand hectares. (Table 1). It is significant to note that the Punja crop registered a sizeable fall in the percentage of area under HYVs during the late-seventies. Are these symptoms of a widespread disenchantment with the new seed varieties among the cultivators?

(vi) The yield rate has not been high enough to make these varieties terribly attractive. This seems to have been the experience in several other parts of Asia as well, so much so that some even question the appropriateness of calling them high-yielding. "The term 'high-yielding' is a

Table 3: Area Under HYVs of Rice: Three Seasons Combined

(Area in hectares)

| Districts | 1969-70 | 1970-71 | 1971-72 | 1972-74 | 1974-75 | 1975-76 | 1976-77 | 1977-78 | Percentage of area under HYVs (1969-70 to 1977-78) | Coefficient of variation percent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Viri-ppu | Munda-kan | Punja | All seasons |
| Trivandrum | 8829 | 8085 | 6856 | 5530 | 3888 | 5864 | 6736 | 2996 | 16.73 | 18.89 | 31.15 | 24.13 | 18.27 |
| Quilon | 3093 | 1200 | 1054 | 8234 | 4053 | 7632 | 3235 | 5766 | 8.23 | 45.85 | 45.81 | 62.45 | 38.31 |
| Alleppey | 29993 | 27921 | 41174 | 54280 | 26242 | 33444 | 61240 | 35528 | 44.14 | 49.96 | 31.41 | 16.62 | 16.33 |
| Kottayam | 20142 | 23506 | 16399 | 25519 | 12689 | 28626 | 35963 | 22666 | 49.23 | 35.05 | 43.03 | 20.26 | 59.60 |
| Ernakulam | 17120 | 21453 | 26936 | 20785 | 17902 | 25054 | 30123 | 32202 | 24.26 | 25.02 | 7.31 | 24.59 | 18.48 |
| Trichur | 20911 | 29310 | 20976 | 35699 | 23117 | 36360 | 36942 | 29014 | 24.44 | 17.74 | 18.78 | 25.02 | 16.63 |
| Palghat | 16097 | 17207 | 20143 | 56270 | 33632 | 46262 | 40739 | 11110 | 19.50 | 55.67 | 46.51 | 0.00 | 26.54 |
| Malappuram | .. | 15485 | 18911 | 22393 | 19787 | 25691 | 17766 | 17448 | 21.65 | 21.75 | 27.73 | 24.09 | 14.91 |
| Kozhikode | 12865 | 4211 | 2404 | 6850 | 10670 | 14710 | 7547 | 9107 | 12.85 | 76.52 | 96.26 | 14.61 | 78.81 |
| Cannanore | 4023 | 10331 | 4156 | 8350 | 13161 | 17756 | 9643 | 1436 | 10.69 | 43.15 | 53.37 | 48.71 | 45.43 |

Note: Data for 1972-73, not available data for Idukki district which was formed in are omitted.

Source: 1. Bureau of Economics and Statistics, Economic Review, Kerala (Annual Series), Government of Kerala, Trivandrum
2. -do- Report on Crop Cutting Surveys (Seasonal Series) Govt. of Kerala, Trivandrum

misnomer. Alone, the new dwarf seeds are not necessarily any more 'high-yielding' than are the greater supplies of fertiliser or improved water system upon which they so ineluctably depend.[1/] The average yield of HYVs in Kerala for the period 1970-78 came to only 1841 kg. of rice (2760 kg. of dry paddy) per hectare. Even for the Punja crop, the average for the above period worked out to only 2085 kg. of rice per hectare. The highest ever yield is seen to have been reaped during 1971-72 when it was 2374 kg. of rice per hectare for Punja and 2150 kg. for the three seasons combined. Since then, the yield rate has fluctuated around a lower level. These rates are less than one-half the potential yields claimed for the new varieties or the actual yield rate of rice in some countries like Japan. Further, here the yield rates are not only low, but also highly unstable; the coefficient of variations for HYVs is generally higher than for local varieties. (Table 4; see also Appendix Table 1). On the other hand, the inherent vulnerability of the new seeds like greater susceptibility to the attacks of pests and diseases has surfaced more visibly in recent years. To this

Table 4: Comparative Performance of the HYVs and Local Varieties of Rice in Kerala

| | Virippu | | Mundakan | | Punja | | Combined | |
|---|---|---|---|---|---|---|---|---|
| | HYVs | Local varieties | HYVs | Local varieties | HYVs | Local varieties | HYVs | Local varieties |
| 1. Average yield rate 1969-70 to 1977-78 (kg. of rice per ha) | 1778 | 1288 | 1638 | 1453 | 2064 | 1383 | 1850 | 1358 |
| 2. Ratio of Yield: Local varieties to that of HYVs | 1 : 1.38 | | 1 : 1.13 | | 1 : 1.49 | | 1 : 1.36 | |
| 3. C.V. of Yield Rates: per cent | 10.49 | 5.26 | 9.48 | 5.48 | 13.27 | 17.49 | 8.35 | 5.57 |

Source: Same as Table 1.

1/ Ingrid Palmer, Science and Agricultural Production, UNRISD,

question we shall revert in the later part of this paper. Suffice it to say here that the performance of the new seed varieties in the State as a whole leaves very much to be desired.

## II. The Study Region and Sample Cultivators

(i) The present paper is based on the findings of an enquiry into the factors underlying the adoption of HYVs of rice in Kerala and the socio-economic implications of the introduction of the new seed-fertilizer technology in the environmental and institutional setting obtained in the State.

(ii) The study was conducted in selected areas of Palghat and Kuttanad. These two regions are the leading rice farming areas of the State, often described as the "rice bowls" of Kerala. It is worth recalling that Palghat and Alleppey (the major part of Kuttanad is situated in Alleppey) are the two districts selected for the implementation of the Intensive Agricultural District Programme (IADP) in the early sixties, apparently because they met the eligibility criteria, such as "assured water supply, freedom from natural hazards, well-developed village institutions - chiefly cooperatives and panchayats - and potentialities for rapid increase in agricultural production."[5/] However, the two regions, Kuttanad and Palghat, differed in many respects: in climate and rainfall, soil and topography, irrigation facilities, cropping pattern, cultivation practices, level of literacy and education, etc.

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5/ Evaluation Division, Report on Intensive Agricultural District Programme in Kerala, State Planning Board, Government of Kerala, Trivandrum, 1971, p.4

Palghat district has a relatively high temperature, the maximum temperature during a normal year being higher than in Alleppey district. The average annual rainfall (1901-50) in the district comes to 2459 mms., as against 3021 mms. for Alleppey district. Further, in Palghat the precipitation is distributed over fewer months, May-November, than in Alleppey where it is spread over a longer period. The study region in the former district, comprising Alathur and Palghat taluks, is characterised by moderately sloped lands with loamy soil. The paddy fields in Kuttanad are mostly lands reclaimed from the backwaters and the soil types found here are peat or 'kari' and alluvial soils. These fields lying several feet below the sea level, are submerged during monsoon; before sowing the fields are dewatered. Palghat is comparatively more favourably endowed with irrigation facilities; the two villages included in this study fall within the ambit of some medium and major irrigation projects. However, cultivation operations continue to depend on the monsoons.[6/] In the case of Kuttanad, the channels surrounding the blocks of paddy fields are always at a higher level and water can be let into the field whenever needed. However, the entire network of backwaters and canals around the paddy fields is open to salinity intrusion once the North East Monsoon recedes and the direction of the flow into the sea is reversed. Breach of outerbunds around the 'padasekharams' (blocks of paddy fields), which are repaired every year, is another risk involved in paddy cultivation in Kuttanad. In Palghat, three crops, viz., Virippu, Mundakan and Punja, are grown, but the first two together cover 97 per cent of the gross area under rice. In Kuttanad one to two crops are raised; the Punja is the

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6/ Francine R. Frankel, India's Green Revolution - Economic Gains and Political Costs, Princeton University Press, 1971, p.122.

dominant crop, and a second crop is raised depending upon the location of the padasekharam and the weather. During the period of the survey, in both the Kuttanad villages, Punja and Virippu were reported by the cultivators. The average density of population is relatively low in Palghat district, and the opposite is true of Kuttanad. The average level of literacy for the study region in Palghat came to about 52 percent in 1971, as against little over 74 percent in Kuttanad. In both the regions, the rate of worker participation was low, 36-37 per cent, according to 1971 census. Among those reported as workers, agricultural labourers constituted a high proportion, about 56 per cent and 69 per cent in the two study regions from Palghat and Kuttanad respectively.

Two Census villages each were selected purposively from Palghat and Kuttanad, keeping in view the importance of rice crop, socio-cultural background, and infrastructure facilities such as irrigation, cooperative credit, extension services, etc. Cultivator households were selected by stratified random sampling; the total number of sample cultivator households came to 317, of which 140 belonged to Palghat and 177 to Kuttanad.*

Table 5 shows the composition of land holdings in terms of wet (paddy) and dry (garden) lands. On the average, almost nine-tenths of a holding comprises wet land; the extent of wet land increases with size of holdings more than that of dry land. The size distribution of sample holdings is given in Table 6. The average size of holdings ranges from 4.9 acres in Akathethara to 6.3 acres in Kainakary. The range is from 0.9 acre

* After complete enumeration of the operational holdings, they were stratified into different size groups. From each size group, certain proportion of sample were drawn at random, the proportion varying from group to group; the proportion being larger for size groups with smaller number of holdings in the list.

Table 5: Composition of Land holdings (acres)

| Size Class (acres) | Akathethara | | | Thenkurissy | | | Thekazhy | | | Kainakary | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wet | Dry | Total | Wet | Dry | Total | Wet | Dry | Total | Wet | Dry | Tot |
| -.62 | 0.39 | 0.12 | 0.51 | 0.21 | 0.23 | 0.44 | 0.27 | 0.13 | 0.40 | 0.28 | 0.14 | 0. |
| -1.25 | 0.65 | 0.18 | 0.83 | 0.66 | 0.32 | 0.98 | 0.52 | 0.28 | 0.80 | 0.81 | 0.18 | 0. |
| -2.50 | 1.46 | 0.26 | 1.72 | 1.48 | 0.27 | 1.75 | 1.32 | 0.47 | 1.79 | 1.71 | 0.13 | 1. |
| -5.00 | 3.03 | 0.42 | 3.50 | 2.68 | .90 | 3.60 | 2.80 | 0.62 | 3.43 | 3.05 | 0.34 | 3. |
| -10.0 | 5.41 | 1.56 | 6.97 | 6.36 | 1.72 | 8.08 | 5.78 | 1.19 | 6.97 | 5.62 | 0.66 | 6. |
| 10 and above | 14.67 | 1.10 | 15.77 | 16.23 | 1.38 | 17.61 | 20.28 | 2.07 | 22.35 | 24.06 | 1.02 | 25. |
| ALL | 4.27 | 0.61 | 4.88 | 4.60 | 0.80 | 5.40 | 5.16 | 0.79 | 5.95 | 5.92 | 0.41 | 6 |

Table 6: Distribution of the Sample Holdings according to Size (all-Land)

| Size class (acres) | Akathethara | | | Thankurissy | | | Thekazhy | | | Kainakary | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of holdings | Percentage of holdings | Average area | No. of holdings | Percentage of holdings | Average area | No. of holdings | Percentage of holdings | Average area | No. of holdings | Percentage of holdings | Average area |
| 0 - 0.62 | 4 | 6.56 | 0.51 (1.99) | 8 | 10.13 | 0.44 (1.33) | 10 | 11.90 | 0.40 (4.11) | 11 | 11.83 | 0.42 (1.49) |
| 0.62 - 1.25 | 6 | 9.83 | 0.83 (4.36) | 8 | 10.13 | 0.98 (3.67) | 13 | 15.47 | 0.80 (6.63) | 16 | 17.20 | 0.99 (4.17) |
| 1.25 - 2.50 | 16 | 26.23 | 1.72 (16.73) | 16 | 20.25 | 1.75 (8.33) | 18 | 21.43 | 1.79 (16.02) | 15 | 16.12 | 1.83 (13.10) |
| 2.50 - 5.00 | 18 | 29.51 | 3.50 (31.47) | 15 | 18.99 | 3.60 (23.33) | 15 | 17.86 | 3.43 (19.39) | 21 | 22.57 | 3.39 (19.94) |
| 5.00 - 10.00 | 12 | 19.67 | 6.97 (27.89) | 16 | 20.25 | 8.08 (25.33) | 12 | 14.29 | 6.97 (19.34) | 12 | 12.90 | 6.28 (10.45) |
| 10.00 and above | 5 | 8.20 | 15.78 (17.54) | 16 | 20.25 | 17.61 (33.00) | 16 | 19.05 | 22.35 (33.70) | 18 | 19.36 | 25.03 (42.06) |
| Total | 61 | 100.00 | 4.88 | 79 | 100.00 | 5.40 | 84 | 100.00 | 5.95 | 93 | 100.00 | 6.33 |

Note: Figures in brackets are the percentage shares of land of each size class.

in the lowest size class to a little over 25 acres in the top size class in the latter village. Though the disparity is a bit narrower in the other three villages, still it is considerable there also. It may also be noted that the share of land is out of proportion to the number of holdings, especially in the two extreme size groups. More about inequality later.

As for the tenurial status, the extent of tenancy used to be greater in the Malabar districts than in Travancore and Cochin. According to a field survey conducted towards the end of 1950s, the proportion of owner-cultivators to the total number of households (including landless households) came to 10 per cent in Malabar and 18 per cent in Kuttanad; the percentage of tenant-cultivators was 75 percent and 35 percent in Malabar and Kuttanad respectively.7/ By the mid sixties, leased-in land as a proportion of total wet land worked out to 46 percent in Travancore, 73 percent in Cochin and 70 percent in Malabar.8/ Frankel reporting on the situation in the late sixties, observed that in Palghat district, "the overwhelming majority of cultivators are customary Verumpathadars; on the whole, about 60 to 70 percent of the land in the district is currently cultivated by Verumpathadars."9/ However, the permanent rights of Verumpatham tenants were strengthened under the Kerala Land Reforms Act of 1964, which offered security of tenures on all tenants and prohibited

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7/ T.C.Varghese, Agrarian Change and Economic Consequences. Land Tenures in Kerala. 1850-1960, Allied Publishers, 1970 Table 3, p.161.

8/ Centre for Development Studies, Poverty, Unemployment and Development Policy - A Case Study of Selected Issues with Reference to Kerala, United Nations, 1975, Table 24, p.63.

9/ Frankel, op.cit., p.129.

evictions except in case of a court order showing adequate reason. Further, the 1969 amendment of the 1964 Act practically abolished tenancy. This is to some extent reflected in the data thrown up by our survey.

The tenurial status of the sample cultivators is presented in Table 7. Evidently, the vast majority of the cultivators are owner-cultivators. Pure tenants are totally absent in three villages; and even in the fourth village there are just two pure tenant farmers among a sample of 84 households, the extent of land leased-in by them being less than 2 acres. The mixed category of owner-tenants is present in all the villages; the average area under these holdings is found to be larger than that of owner-cultivators. As tenancy stands abolished from the beginning of the early seventies, the category of owner-cum-tenants presumably represents informal arrangements. Anyhow, it brings out the fact that, as of before, one has to own some land in order to be able to lease-in any bit of it.

The degree of inequality in the ownership of land and other assets is brought out in Table 8. It may be seen that at Akathethara the top decile of households own about 39 percent of land, as against less than 2 percent of the land with the bottom decile; the distribution of land is more skewed in the other three villages. By and large, the degree of inequality is greater in respect of land than of other farm assets (See also Table 9).

Table 7: Distribution of Wet land Holdings according to Tenurial Pattern ( ).

| Size Class (acres) | Akathethara | | | Thenkurissy | | | Thakazhy | | | Kainakary | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Owner cultivators | Tenant cultivators | Owner tenants | Owner cultivators | Tenant cultivators | Owner Tenants | Owner cultivators | Tenant cultivators | Owner tenants | Owner cultivators | Tenant cultivators | Owner tenants |
| | (no.) | (no.) | (no.) | (no.) | (No.) | (no.) | (no.) | (no.) | (no.) | (no.) | (no.) | (no.) |
| -0.62 | 7 | .. | .. | 12 | .. | 1 | 20 | .. | .. | 11 | .. | .. |
| -1.25 | 8 | .. | .. | 8 | .. | .. | 10 | .. | .. | 13 | 2 | 1 |
| -2.50 | 15 | .. | .. | 12 | ... | 2 | 15 | .. | .. | 19 | .. | .. |
| -5.00 | 14 | .. | 2 | 5 | .. | 9 | 14 | .. | 1 | 16 | .. | 1 |
| -10.00 | 6 | .. | 4 | 7 | .. | 13 | 9 | .. | 1 | 10 | .. | 2 |
| 10 and above | 3 | .. | 2 | 1 | .. | 9 | 10 | .. | 5 | 15 | .. | 3 |
| ALL | 53 | .. | 8 | 45 | .. | 34 | 78 | .. | 6 | 84 | 2 | 7 |

Table 3: Distribution of Assets

| Village | Fractile Shares (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Bottom 10% | | | Top 10% | | | Top 5% | | |
| | Land | Farm Assets* | Fin. Assets | Land | Farm Assets | Fin. Assets | Land | Farm Assets | Fin. Assets |
| Akothethara | 1.66 | 0.00 | 1.14 | 28.86 | 31.90 | 34.83 | 33.86 | 17.20 | 22.20 |
| Thenkurissy | 0.66 | 0.05 | 0.13 | 43.62 | 33.69 | 66.20 | 26.10 | 16.85 | 44.91 |
| Thekazhy | 0.80 | 0.00 | 0.09 | 50.32 | 55.85 | 37.85 | 30.47 | 39.11 | 21.70 |
| Kainakary | 1.43 | 1.40 | 1.56 | 53.54 | 54.94 | 41.57 | 39.05 | 43.40 | 25.36 |

*Non-land physical assets including bullocks, buffaloes, other cattle, ploughs and other implements, etc.

Table 9: Inequality in the distribution of wet land and non-land assets (physical and financial) in Akathethara, Thenkurissy, Thakazhy and Kainakary

| Village | Wetland G.C. | Non-land assets G.C | Physical assets G.C. | Finacial assets G.C. |
|---|---|---|---|---|
| Akathethara | 0.4295 | 0.2934 | 0.3252 | 0.2783 |
| Thenkurissy | 0.5404 | 0.6367 | 0.4998 | 0.6738 |
| Thakazhy | 0.6243 | 0.4609 | 0.5331 | 0.4390 |
| Kainakary | 0.6054 | 0.3620 | 0.5233 | 0.3945 |

GC = Gini Coefficient.

## III. Adoption Rates of HYVs

(i) It has been hypothesised that the pattern of adoption of the new seed varieties takes the form of an S-curve. According to this hypothesis within an area, only a small proportion of farmers first take to the new seeds; their dispersal encourages through a demonstration effect an acceleration of new adopters (formerly of wait-and-see masses). After this stage, there is a gradual levelling-off at the top of the S-curve, when stragglers slowly come to practice, but generally leaving a small minority which is either unable or unwilling to take up this innovation.[10/] The results of a few case studies of adoption rates would seem to support

10/ Ingrid Palmer, The New Rice in Asia: Conclusions From Four Country Studies, United Nations Research Institute for Social Development, Geneva, 1976, p.59.

this hypothesis.[11/] However, in some countries covered by the studies on New Rice in Asia by the UNRISD, some adopters have been disillusioned with the new varieties and, therefore, abandoned them subsequently.

Data on the first year of adoption of HYVs and the seed varieties sown were collected from among the sample cultivators. The time profile of adoption of HYVs is presented in Table 10. In our study region also, the spread of HYVs seems to fall into the same pattern as depicted above. Initially only a minority of enterprising cultivators are prepared to adopt the new seeds and the associated technology, and naturally so. But as the new seeds appeared to be profitable, more cultivators are attracted into it.

The new seed varieties had an early start in Kuttanad compared to Palghat, and the rate of spread was also faster in Kuttanad region. Thus, in the course of the first four years since the introduction of HYVs, about 51 percent of the sample cultivators in Kuttanad had adopted HYVs, as against 10 percent in Palghat. However, in the subsequent years adoption rate in Palghat caught up.

(ii) As Ingrid Palmer rightly points out, it would be much more interesting to know which category of farmers, in particular, adopts first and which rejects later. "Data can be found to prove any theory and because the data are not comprehensive and doubtfully representative, generalisations

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11/ U.N. Bhati, "Some Social and Economic Aspects of the Introduction of New Varieties of Paddy in Malayasia - A Village Case Study", United Nations Research Institute for Rural Development, 1976, p.131.

Table 10: Rate of adoption of HYV of Rice in Sample Holdings

| Period of first adoption | Akathethara | | Thonkurissy | | Thakazhy | | Kainakary | |
|---|---|---|---|---|---|---|---|---|
| | No. | Percent | No. | Percent | No. | Percent | No. | Percent |
| 1966-69 | 6 | 9.84 | 8 | 10.13 | 53 | 63.09 | 37 | 39.78 |
| 1970-72 | 51 | 83.61 | 50 | 63.29 | 23 | 27.38 | 32 | 34.41 |
| 1973 and after | 3 | 4.92 | 16 | 20.25 | 3 | 3.57 | 10 | 10.75 |
| Total Adoption | 60 | 98.36 | 74 | 93.67 | 79 | 94.05 | 79 | 84.95 |
| Total Sample Holding | 61 | - | 79 | - - | 84 | .. | 93 | .. |

are dangerous."[12] As to the factors which influence adoption rates, size of holdings, assets, access to information, new inputs and credit, tenurial status, irrigation facility, level of literacy, etc. have been listed by different researchers.[13] On the other hand, there are some who question any association between the above variables and rates of adoption of HYVs.[14]

Among our sample cultivators, by and large, the early adopters had larger holdings. Evidently they would command more resources and access to information, inputs and credit. Perhaps, over time the resource-barriers to entry were lowered, partly as a result of the Government's active involvement in the propagation of new seeds, and cultivators with smaller holdings entered the scene.

(iii) By 1972 nearly three-quarters of the sample cultivators as a whole had adopted HYVs. Since then, apparently the share of HYVs has increased to some extent in all the four villages. The proportions of area under HYVs, nationally Improved Varieties (NIVs) and Traditional Varieties (TVs) during the study period 1976-77 are summaries in Table 11.

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12/ Palmer, op.cit.,p.62.

13/ See, for example; (i) G. Muthiah, "The Green Revolution - Participation by Small Vs. Large Farmers", Indian Journal of Agricultural Economics, Vol.XXVI, No.1, 1971, pp.54-56. (ii) G. Parthasarathy and Prasad, op.cit.,pp.1519-1521.

14/ Bandhudas Sen, The Green Revolution in India: A Perspective, 1974, pp.32-33; See also, P.K. Mukherjee, "HYV Programme - The Variables That Matter", Economic and Political Weekly, Review of Agriculture, March 1970, p.A.22.

Table 11: Percentage of Area Under Broad Categories of Seed, 1975-76

| | Akathethara | | | Thenkurissy | | | Kainakary | | | Thakazhy | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HYVs | NIVs | TVs | HYVs | NIVs | TVs | HYVs | NIVs | TVs | HYVs | NIVs | TVs |
| Mundakan | 59.87 | 32.96 | 7.7 | 79.74 | 19.84 | 0.42 | .. | .. | .. | .. | .. | .. |
| Punja | 100.00 | .. | .. | 89.15 | .. | 10.84 | 77.55 | 22.45 | .. | 100.00 | .. | .. |
| Virippu | 100.00 | .. | .. | 99.14 | .. | 0.85 | 81.74 | 18.26 | .. | 99.38 | 0.62 | |

It may be noted that, the entire area among the sample holdings under Virippu in the two Palghat villages is sown to HYVs; during the Punja season, HYVs cover the total area in one of them and about nine-tenths of the area in the other village. The proportion during Mundakan, a major paddy season here, is comparatively less. It,however, needs to be noted that the coverage of the HYVs among the sample holdings in these two villages is far greater than the district averages as reported in the official statistics. In the two villages of Kuttanad, only two crops, viz., Virippu and Punja, were raised during the reference period; of these, Punja is the main crop. In one of these villages, HYVs account for almost the entire area during both these seasons; in the second village, the percentage of area under HYVs is a little less. In Table 12, we give the distribution of area under the three categories of seed varieties among holdings of different size groups. We do not find any consistent differences in the adoption rates as between cultivators of different strata either.

(iv) The area under different seed varieties grown in the sample holdings is shown in Table 13. Quite a few HYVs are reported in the study areas such as IR8 and its variants, Jaya, Triveni, Jyothi, Masoori, Rohini, etc. However, in the Palghat villages Masoori and Jaya dominate the two major seasons, Virippu and Mundakan, while Triveni has the major share of area during Punja. In Kuttanad villages, Jyothi and Jaya together account for the bulk of the area under HYVs* Broadly speaking, the dominant

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*Of these HYVs, Jaya, developed at the All-India Co-ordinated Rice Improvement Project (AICRIP), Hyderabad, is a cross between TN(I) and T141. Of 120-130 day's duration, it has qualities of wide adaptability and high stable yield. The yield potential is put at 8 tonnes of dry paddy per hectare. Masoori (Mayang Ebes 80/2xTaichung 65) is taller than IR8, and well suited for deeper soils with poor drainage. Its duration is 140 days. This variety is recommended for problem soils where IR8, Jaya or Aswathi

Table 12: Proportion of Area Under Broad Groups of Seed Varieties

| Wet Size class(acres) Season | | AKKIMETHALA | | | | | | THENKURISSY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HYV | | NIV | | TV | | HYV | | NIV | | TV | |
| | | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent |
| 00 - .62 | M | 1.94 | 82.91 | 0.40 | 17.90 | - | - | 3.28 | 74.55 | 1.12 | 25.45 | - | - |
| | P | 1.01 | 100.00 | - | - | - | - | 1.10 | 100.00 | - | - | - | - |
| | V | 2.84 | 100.00 | - | - | - | - | 4.55 | 100.00 | - | - | - | - |
| .62 - 1.25 | M | 3.07 | 39.51 | 3.90 | 50.19 | 0.80 | 10.30 | 7.66 | 78.24 | 2.13 | 21.76 | - | - |
| | P | 6.97 | 100.00 | - | - | - | - | - | - | - | - | - | - |
| | V | 7.77 | 100.00 | - | - | - | - | 10.39 | 100.00 | - | - | - | - |
| 1.25 - 2.5 | M | 20.05 | 91.34 | 1.90 | 8.66 | - | - | 18.77 | 86.22 | 3.00 | 13.78 | - | - |
| | P | 22.95 | 100.00 | - | - | - | - | 4.35 | 100.00 | - | - | - | - |
| | V | 24.45 | 100.00 | - | - | - | - | 21.90 | 100.00 | - | - | - | - |
| 2.5 - 5.00 | M | 28.08 | 51.43 | 26.52 | 48.57 | - | - | 31.55 | 72.91 | 11.72 | 27.09 | - | - |
| | P | 37.26 | 100.00 | - | - | - | - | 2.00 | 100.00 | - | - | - | - |
| | V | 57.22 | 100.00 | - | - | - | - | 39.02 | 96.29 | - | - | 1.50 | 3.70 |
| 5 - 10.00 | M | 41.31 | 65.48 | 18.78 | 29.77 | 3.00 | 4.76 | 96.89 | 79.28 | 25.31 | 20.71 | - | - |
| | P | 54.09 | 100.00 | - | - | - | - | 13.50 | 79.41 | - | - | 3.50 | 20.59 |
| | V | 62.60 | 100.00 | - | - | - | - | 121.22 | 100.00 | - | - | - | - |
| 10 and above | M | 49.37 | 77.13 | 14.64 | 22.87 | - | - | 145.08 | 81.93 | 32.00 | 18.07 | - | - |
| | P | 29.37 | 100.00 | - | - | - | - | 15.00 | 100.00 | - | - | - | - |
| | V | 64.01 | 100.00 | - | - | - | - | 161.51 | 100.00 | - | - | - | - |

contd....

Table 12: Proportion of area under Broad Groups of Seed Varieties

| Wet Size Class(acres) Season | | THEKKAZHY | | | | | | KAINAKARY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HYV | | NIV | | TV | | HYV | | NIV | | TV | |
| | | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent |
| 00 - .62 | P | 7.67 | 100.00 | - | - | - | - | 2.60 | 86.45 | 0.42 | 13.55 | - | - |
| | V | .30 | 38 46 | - | - | .48 | 61.53 | 3.38 | 100.00 | - | - | - | - |
| .62 - 1.25 | P | 9.13 | 100.00 | - | - | - | - | 8.23 | 89.17 | 1.00 | 10.83 | - | - |
| | V | 2.00 | 100.00 | - | - | - | - | 5.23 | 83.95 | 1.00 | 16.05 | - | - |
| 1.25- 2.50 | P | 23.99 | 100.00 | - | - | - | - | 19.71 | 84.92 | 3.50 | 15.08 | - | - |
| | V | 4.27 | 100.00 | - | - | - | - | 14.81 | 90.80 | 1.50 | 9.20 | - | - |
| 2.5 - 5.00 | P | 43.24 | 100.00 | - | - | - | - | 50.09 | 93.82 | 3.30 | 6.18 | - | - |
| | V | 4.71 | 100.00 | - | - | - | - | 40.39 | 92.45 | 3.30 | 7.55 | - | - |
| 5.0 - 10.0 | P | 66.03 | 100.00 | - | - | - | - | 38.85 | 100.00 | - | - | - | - |
| | V | - | - | - | - | - | - | 30.24 | 100.00 | - | - | - | - |
| 10.00 and above | P | 308.02 | 100.00 | - | - | - | - | 369.33 | 89.14 | 45.00 | 10.86 | - | - |
| | V | 65.62 | 100.00 | - | - | - | - | 233.26 | 96.75 | 8.00 | 3.25 | - | - |

Table 13: Area Under Different Seed Varieties (1975-76) - Palghat

| Seed variety | Akathethara | | | | | | Thenakurissy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mundakan | | Punja | | Virippu | | Mundakan | | Punja | | Virippu | |
| | Area | Percent | Area | Percent | Area | Percent | Area | Percent | Area | Percent | Area | Percent |
| A. HYV: 1. Jaya | 68.12 | 33.45 | 5.0 | 3.15 | 66.15 | 29.74 | 64.56 | 16.44 | .. | .. | 115.59 | 32.82 |
| 2. Triveni | 0.50 | 0.25 | 145.95 | 91.87 | 4.24 | 1.91 | 45.80 | 11.66 | 32.45 | 78.29 | 62.09 | 17.63 |
| 3. IR5 | | | | | | | | | | | 0.60 | 0.17 |
| 4. IR 8 | | | | | 0.50 | 0.22 | 17.74 | 4.52 | | | 73.54 | 20.89 |
| 5. IR 20 | | | | | | | 60.84 | 15.50 | | | 24.99 | 7.10 |
| 6. Rohini | | | | | | | 1.50 | 0.38 | | | 2.50 | 0.71 |
| 7. Aswathi | | | | | | | | | | | 11.40 | 3.24 |
| 8. Annapoorna | | | | | | | | | 2.50 | 6.03 | 0.36 | 0.10 |
| 9. Jyothi | 17.56 | 8.62 | 5.60 | 3.53 | 0.50 | 0.22 | | | | | | |
| 10. Supriya | | | | | | | 0.75 | 0.19 | | | | |
| 11. Subhashini | 1.00 | 0.49 | | | | | | | | | | |
| 12. Masoori | 34.74 | 17.06 | 2.30 | 1.45 | 151.04 | 67.90 | 121.90 | 31.05 | 2.00 | 4.83 | 57.52 | 16.34 |
| 13. Bhavani | | | | | | | | | | | 0.50 | 0.14 |
| Sub-Total | 121.92 | 59.87 | 158.85 | 100 | 222.43 | 100.00 | 313.09 | 79.74 | 36.95 | 89.15 | 349.09 | 99.14 |
| B. Nationally/Locally Improved Varieties: | | | | | | | | | | | | |
| 14. CO 19 | 27.62 | 13.56 | | | | | 51.15 | 13.03 | | | | |
| 15. CO 20 | 3.00 | 1.47 | | | | | | | | | | |
| 16. CO 25 | 36.52 | 17.93 | | | | | 5.61 | 1.43 | | | | |
| 17. CO 29 | | | | | | | 20.13 | 5.13 | | | | |
| 18. [illegible] 12 | | | | | | | 1.00 | .25 | | | | |
| Sub-Total | 67.14 | 32.96 | | | | | 77.89 | 19.84 | | | | |
| C. Others | | | | | | | | | | | | |
| 19. Cherumanian | | | | | | | 0.65 | 0.17 | | | | |
| 20. Chembav | | | | | | | | | 3.5 | 8.44 | 2.00 | 0.57 |
| 21. Combanchettni | 3.80 | 1.87 | | | | | | | | | | |
| 22. Others | 10.00 | 5.30 | | | | | 1.00 | 0.25 | 1.00 | 2.41 | 1.00 | 0.29 |
| Sub-Total | 14.60 | 7.17 | | | | | 1.65 | .42 | 4.50 | 10.85 | 3.00 | 0.85 |
| TOTAL | 203.66 | 100.00 | 158.85 | 100.00 | 222.43 | 100.0 | 392.63 | 100.00 | 41.45 | 100.00 | 352.09 | 100.00 |

Table 13 (contd.): Area Under Different Seed Varieties:(1975-76) : Kuttanad

| Seed variety | Kainakary | | | | Thakazhy | | | |
|---|---|---|---|---|---|---|---|---|
| | Punja | | Virippu | | Punja | | Virippu | |
| | Area(acres) | Percent | Area | Percent | Area | Percent | Area | Percent |
| A. HYV: 1. Jaya | 21.50 | 3.97 | 76.14 | 21.52 | 95.21 | 20.10 | 24.41 | 31.08 |
| 2. Triveni | 29.95 | 5.53 | 7.45 | 2.11 | 4.75 | 1.00 | | |
| 3. IR 8 | .. | .. | 14.06 | 3.97 | 1.50 | 0.32 | | |
| 4. IR 20 | | | | | 5.69 | 1.20 | | |
| 5. IR 24 | 3.18 | 1.51 | 7.68 | 2.17 | | | | |
| 6. IR 225 | 3.61 | 0.67 | 6.10 | 1.71 | | | | |
| 7. Aswathi | 33.40 | 6.17 | 11.00 | 3.11 | | | | |
| 8. Annapoorna | 8.00 | 1.48 | ... | ... | 0.63 | 0.13 | | |
| 9. Jyothi | 259.50 | 37.92 | 142.80 | 40.36 | 269.45 | 56.88 | 46.82 | 59.62 |
| 10. Bharathi | 6.00 | 1.11 | 6.00 | 1.70 | | | | |
| 11. Kanchi | 40.40 | 7.46 | 18.00 | 5.09 | 96.48 | 20.37 | 6.82 | 8.68 |
| 12. Manila | 9.35 | 1.73 | ... | .. | .. | | | |
| Sub-Total | 419.89 | 77.55 | 289.23 | 81.74 | 473.71 | 100.00 | 78.05 | 99.38 |
| B. Nationally/Locally Improved Varieties: | | | | | | | | |
| C. Others: 13. Mysore Vella | | | | | | | 0.48 | 0.62 |
| 14. Chandra Bindu | 10.00 | 1.84 | | | | | | |
| 15. Jaya Chandra | 1.50 | 0.27 | | | | | | |
| 16. A.P.W. | 35.00 | 6.61 | 11.30 | 3.19 | | | | |
| 17. Culture S & 20 | 74.33 | 13.73 | 53.33 | 15.07 | | | | |
| Sub-Total | 121.63 | 22.45 | 64.63 | 18.26 | | | 0.48 | 0.62 |
| TOTAL | 541.52 | 100.00 | 353.86 | 100.00 | 473.71 | 100.00 | 78.53 | 100.00 |

varieties in the two regions reflect the cropping seasons, consumer preference and price differential, straw yield, etc. It may also be noted that NIVs continue to occupy a significant proportion of the area, especially in the Palghat region. The NIVs are characterised by fine, locally preferred rice and higher straw yield.

## IV. Performance of HYVs

(i) An obvious yardstick for measuring the performance of the new seed varieties is the yield rate. We had earlier referred to the lower-than-expected yield rates of HYVs in the State as a whole. But, then, Palghat and Kuttanad are comparatively more favourably endowed regions for the rice crop. It is also worth mentioning that the paddy crop in the study areas enjoyed favourable conditions during the year under survey, 1976-77. Kuttanad was free from drought conditions, which affected many parts of Alleppey district during Virippu season; the Mundakan and Punja

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may not perform well. One weakness of Masoori is (PTB 15 x Annapurna) has been developed by the Rice Research Station at Pattambi in Kerala. It is a short duration seed, 100-105 days, its yield potential is placed at 6 tonnes of paddy. This variety is susceptible to certain diseases like sheath blight and blast. Jyothi (PTB 10 x IR8) also developed by the Patambi Rice Research Station is a short duration crop (105 days). It has a record of consistently high yield, on experimental station, of around 6 tonnes of paddy. This variety is said to be resistant to blast and to show field tolerance to brown hopper.

The above description of the genetic characteristics of the seed varieties is based on some notes supplied by Dr.R.Gopalakrishnan, Centre for Water Resources Development and Management, and Dr. K.N.Syamasundaran Nair, Kerala State Planning Board.

crops were reported to be good throughout the district. The rainfall and crop conditions were highly favourable for a bumper crop, in all taluks of Palghat district.[15] Against this background let us examine the yield rates of the new varieties among the sample holdings.

Table 14: Yield Rates of HYVs, Seasonwise, Among Sample Holdings

(kg. of dry paddy per hectare)

| Village | Virippu | Mundakan | Punja |
|---|---|---|---|
| Akathethara | 2322 | 2197 | 2288 |
| Thenkurissy | 3596 | 3176 | 2636 |
| Thakazhy | 2458 | .. | 2779 |
| Kainakary | 3243 | .. | 3120 |

(ii) The average yield rate seems to range from 2200 kg. to 3600 kg. of paddy per hectare among the four villages.* This cannot be considered high when viewed against the genetic potentialities claimed for these varieties and the comparatively favourable environmental and weather conditions that were obtained during the reference period. The estimated yield potentials of Jaya, Jyothi, Triveni, etc. are in the range of 6-8 tonnes per hectare, more than twice the yield reported in our sample holdings on the average. Now let us see how the HYVs compare with other seed varieties.

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15/ Bureau of Economics and Statistics, Season and Crop Report for Kerala State, 1976-77, Government of Kerala, Trivandrum, 1977, pp.16-17.

*The data on yield were collected by recall method; however, the memory lapse is apt to be less as the investigators were in constant contact with the respondents and the time interval was short. Still, the reported yield might contain a margin of error.

It may be recalled (Table 11) that among the sample holdings the adoption has been quite high. The HYVs cover the entire area in some villages and/or during some seasons. The rest of the area is under the NIVs; the traditional varieties have almost totally disappeared. But the number of observations on the non-HYVs is not large enough in each village for comparison of the relative performance. This limitation may be borne in mind while comparing the yield rates of groups of seed varieties presented in Table 15.

Table 15: Comparative Yields of HYVs, NIVs and TVs

| Village | HYVs | NIVs | TVs |
|---|---|---|---|
| Akathethara (Mundakan) | 2197 | 2494 | 1538 |
| Thonkurissy (Mundakan) | 3176 | 2702 | N.A. |
| Thakazhy (Virippu) | 2458 | N.A. | 2012 |
| Kainakary (Punja) | 3120 | 3367 | N.A. |

It may be noted that in two of the villages, one in Palghat and the other in Kuttanad, Nationally Improved Varieties (NIVs) have apparently out-yielded HYVs. The Nationally Improved Varieties sowed here comprise CO-19, CO-20, CO-25, CO-29 and some earlier breeds of PTB varieties. In a third village, the yield rate of HYVs is higher than NIVs, but by only 17.5 percent. Thus, notwithstanding the limitations involved in the comparison - thanks to the limited number of observations on NIVs - the yield rates of HYVs do not emerge as quite high.

(iii) The relation between farm size and yield rate has been a subject of long-standing debate in the literature. Earlier it was contended that there was an inverse relationship between farm size and productivity, partly based on a priori reasoning and partly on empirical findings. Subsequently, with refinements in methodology it turned out that there existed no inverse relation between the yield per acre of individual crops and farm size, and that the inverse relationship is substantially weakened when output per acre for all crops is related to gross cropped area.[16] How does the introduction of the new seed-fertiliser technology affect the relationship between farm size and productivity? On the one hand, it has been argued that the new technology is scale-neutral; on the other hand, it is pointed out that institutional factors like extension services, credit facilities, prices of inputs and outputs, information dissemination, etc. consistently exhibit a strong bias in favour of large farmers. Summing up the results of various empirical studies of green revolution areas, Roy observed: "It would appear that while there is evidence which suggests a substantial weakening of the inverse relation, the contradictory findings of other studies leave the issue somewhat unresolved."[17] On the basis of his own investigation, Roy formulates the following hypothesis for the impact of agricultural transition like the green revolution:

> "While at the early stages the intrinsic advantages of scale are not unimportant, these became increasingly important over time as they enable the big farmer to maintain high investment and growth rates. This two-stage process implies that in regions where the forces of transition are recent, the first impact is the disappearance of the traditional inverse relation. At a later stage, however, when the scale advantages of bigger farms operate for a substantial length of time, there is a tendency for the relation to turn positive."[18]

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16/ Prannoy Lal Roy, The Relation Between Farm Size and Productivity in the Context of Alternative Mode of Production in Indian Agriculture, thesis submitted for the Ph.D. degree of Delhi University, 1979 (unpublished), p.33.

17/ ibid., p.128.

The average yield rates among the holdings of different size classes are presented in Table 16.

Table 16

Yield Rates of HYVs Among Holdings of Different Size Classes

(kg. of dry paddy per hectare)

| Size Classes (acres) | Akathethara | | | Thenkurissy | | | Thakazhy | | Kainakary | |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | M | P | V | M | P | V | P | V | P |
| 0 - 6.22 | 2404 | 2187 | 2638 | 4598 | 4416 | 1757 | 1656 | 2342 | 3913 | 3729 |
| 0.62 - 1.25 | 2378 | 2383 | 2276 | 2460 | 1847 | .. | 2259 | 2578 | 3087 | 3086 |
| 1.25 - 2.50 | 2387 | 2323 | 2266 | 3139 | 3137 | 2568 | 1649 | 2660 | 3070 | 2909 |
| 2.50 - 5.00 | 2323 | 2038 | 2304 | 3535 | 3053 | .. | 1783 | 2619 | 3370 | 3334 |
| 5.00 - 10.00 | 2381 | 2285 | 2260 | 3495 | 3237 | 3069 | .. | 2457 | 3161 | 3061 |
| 10.00-& above | 2247 | 2193 | 2314 | 3800 | 3192 | 2384 | 2593 | 2912 | 3092 | 3238 |
| All | 2322 | 2197 | 2288 | 3596 | 3176 | 2636 | 2458 | 2279 | 3243 | 3120 |

There seems to be no consistent and significant relation between size of (paddy land) holding and yield rate for any village during any season. Lest the relationship is lost in the process of aggregation, the data on net area sown and yield rate per acre were put to correlation analysis. The results are shown in Table 17.

We find that there is a positive correlation between yield rate and area sown in three out of six crops in Palghat villages. On the other hand, in one of the two Kuttanad villages, there is a negative correlation between yield and area, but it is not significant. In the case of the

other Kuttanad village, sufficient number of observations is obtained during one season only, but they do not show any relationship between area and productivity. Thus the picture emerging from the foregoing analysis is a mixed one.

Table 17

Correlation Between Net Area Sown and Yield Rate of HYVs of Paddy

| Village | Season | Correlation Coefficient | T Value | |
|---|---|---|---|---|
| | | | Computed | 5% Level |
| Akathethara | Mundakan | .365* | 2.772 | 2.01 |
| | Punja | .130 | .918 | 2.01 |
| | Virippu | .126 | .976 | 2.00 |
| Thenkurissy | Mundakan | .280* | 2.221 | 2.00 |
| | Punja | .147 | .364 | 2.45 |
| | Virippu | .303* | 2.698 | 1.995 |
| Thakazhy | Virippu | - | - | - |
| | Punja | .135 | 1.064 | 2.00 |
| Kainakary | Virippu | -.059 | -.487 | -1.995 |
| | Punja | -.094 | -.743 | -2.00 |

*significant at 5 per cent level.

In brief, the yield rates of the new varieties among our sample holdings are below the levels one would expect. True, the data pertain to one year only, and, therefore, any generalisation about the performance of HYVs on this basis is not warranted. But, as noted earlier, the yield rates of HYVs in the State for the period since their introduction taken as a whole have been considerably less than their genetic potentialities, and are also marked by large fluctuations. We shall next examine the possible reasons for the sub-optimal performances of the new varieties in our study areas.

## V. Reasons for the sub-optimal performance

(i) The level and stability of yield rates of the new seeds - for that matter of any rice variety - would depend upon factors such as soil type, moisture level, plant nutrients, and environmental factors. A distinct feature of the new varieties is their high fertiliser-responsiveness. Admittedly, the response of the new varieties to doses of fertilizer, especially nitrogen, is substantially positive, given favourable physical conditions. Certain physiological properties of the new varieties account for this: their leaf erectness and high tillering rate activate nutrient uptake and photosynthesis, while their stiff and dwarf stems help to bear heavier grain load without lodging before harvest. Thus data from trials at experiment stations in the Philippines showed that dwarf IR5 and IR8 might be able to respond positively to application of nitrogen fertilizer beyond 120 kg./ ha. at levels of output of 7000 and 6000 kg./ ha. respectively.[19] However, this degree of response requires favourable physical conditions including healthy soil (in terms of plant nutrients, soil structure and texture), adequate and controlled water supply, and a range of temperature and solar radiation to suit the different phases of the growth cycle.[20] On the other hand, these seeds, respond no better, and sometimes even worse, to fertilizer application than local varieties, if favourable physical and environmental conditions are not obtained.

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19/ Palmer, Science and Agricultural Production, op.cit., p.19.

20/ Ibid., Chapter V.

(ii) Nitrogen input among the sample holdings ranges from 72 to 118 kg./ha. (Table 18). Nitrogen dosage recommended by the Directorate of Extension Education, Kerala Agricultural University, has been 60kg./ha. for high yielding short duration varieties in the uplands and 70 and 90 kg./ha. for high yielding short duration and medium duration varieties respectively in the wet lands.[21] It may be recalled (Table 13) that the leading HYVs sown to the sample holdings in the two Palghat villages during the reference year were Jaya, Triveni and Masoori; of these, the first two may be categorised as medium duration (95-115) days crop, while the last one is a long duration (125-140 days) crop. Among the Kuttanad samples, Jaya and Jyothi (110-115 days) were the main HYVs. The application of nitrogen in the Palghat holdings, 76-78 kg./ha., may therefore be considered to fall a little short of the recommended dosage for medium duration varieties, whereas in the case of Kuttanad holdings the actual input, 87-118 is higher. Thus, the average level of nitrogen input on our sample holdings is fairly close to the recommended dosage.

What has been the response of yield to nitrogen dosage among our sample holdings? Table 19 shows the levels of yield corresponding to different levels of nitrogen application. The variation in yield as the level of nitrogen input increases is found to be erratic; that is, there is apparently no systematic association between nitrogen input and yield rate. Of course, yield response to nitrogen also depends on the levels of phosphorous and potash. In order to fully capture the response

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21/ Directorate of Extension Education, Package of Practices Recommendation, Kerala Agricultural University, Mannuthi, 1975, p.6.

Table 18: Fertilizer Application Among Sample Cultivators (kg./ha)

| Season | Akathethara | | | Thenkurissy | | | Thakazhy | | | Kainakary | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | N | P | K | N | P | K | N | P | K |
| Virippu | 72.49 | 18.56 | 38.80 | 76.58 | 19.36 | 20.95 | | | | 76.65 | 36.71 | 69.1 |
| Mundakan | 81.62 | 18.75 | 42.04 | 82.05 | 24.59 | 26.15 | | | | | | |
| Punja | 74.59 | 18.10 | 35.78 | | | | 117.97 | 61.41 | 83.65 | 95.33 | 45.48 | 91.24 |
| All seasons | 76.03 | 18.47 | 38.89 | 77.79 | 21.84 | 23.33 | 117.97 | 61.41 | 83.65 | 86.50 | 41.33 | 80.78 |

Table 19: Yield Response to Nitrogen Application Among Sample Holdings

Akathethara

| Nitrogen Input level kg./ha. | Mundakan 1975-76 | | Punja 1975-76 | | Virippu 1975-76 | |
|---|---|---|---|---|---|---|
| | No. of holdings | Average yield of paddy Kg./ha | No. of holdings | Average yield of paddy Kg./ha | No. of holdings | Average yield of paddy Kg./ha. |
| 40 | 1 | 2064 | 2 | 2184 | 7 | 2033 |
| 40 - 60 | 9 | 2248 | 14 | 2396 | 18 | 2427 |
| 60 - 80 | 8 | 2083 | 8 | 2458 | 13 | 2356 |
| 80-100 | 10 | 2151 | 15 | 2425 | 12 | 2504 |
| 100 - 120 | 5 | 2322 | 5 | 2162 | 6 | 2469 |
| 120 - 140 | 3 | 2301 | 1 | 1650 | 1 | 2032 |
| 140 + | 2 | 2478 | 3 | 2507 | 3 | 2571 |

Thenkurissy

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | 2 | 2972 | | | 7 | 3203 |
| 40 - 60 | 4 | 3357 | | | 11 | 2932 |
| 60 - 80 | 14 | 2983 | | | 27 | 3478 |
| 80 - 100 | 18 | 3179 | | | 15 | 3702 |
| 100 - 120 | 8 | 3336 | | | 10 | 4300 |
| 120 - 140 | 3 | 3127 | | | 2 | 3406 |
| 140 + | 2 | 3757 | | | 2 | 3307 |

Kainakary

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | | | 1 | 2588 | 6 | 2889 |
| 40 - 60 | | | 5 | 2960 | 6 | 3759 |
| 60 - 80 | | | 14 | 3098 | 21 | 3359 |
| 80 - 100 | | | 14 | 2946 | 11 | 2880 |
| 100 - 120 | | | 14 | 3076 | 4 | 2967 |
| 120 - 140 | | | 5 | 3510 | 3 | 3304 |
| 140 + | | | 5 | 2887 | 1 | 3762 |

Thakazhy

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | | | - | - | | |
| 40 - 60 | | | - | - | | |
| 60 - 80 | | | 6 | 2567 | | |
| 80 - 100 | | | 21 | 2474 | | |
| 100 - 120 | | | 16 | 2744 | | |
| 120 - 140 | | | 12 | 2751 | | |
| 140 + | | | 7 | 2752 | | |

of yield to NPK dosage we therefore fitted the following response function.

$$\begin{aligned} \text{Yield} = {} & a + bN + cP + dK \\ & + cN^2 + fP^2 + gK^2 \\ & + hNP + kNK + lPK \\ & + mNPK + u \end{aligned}$$

From Table 20 it can be seen that, barring a few cases, the coefficients estimated are insignificant in almost every case. $R^2$ values are also not high at all. This does not warrant the inference that there is no positive response to NPK application among our sample holdings. After all, the response of the HYVs to NPK is a function of variety of physical and environmental factors such as controlled water supply and drainage, solar radiation, etc.

(ii) Of these, the quality of irrigation is a crucial determinant of nutrient intake and yield. Broadly speaking, timely and adequate water supply is not available even in the two Palghat villages though they are within the ambit of some of the major irrigation projects; the situation is even more precarious in the Kuttanad villages where the water sources are subject to salinity intrusion during certain months.* Lack of proper drainage is an equally serious problem in these areas where the rice fields get flooded during the monsoons; the problem is more serious for the HYVs that are short stemmed. The main paddy seasons in Kerala being linked to the South-west and North-east monsoons, heavy cloud would adversely affect solar radiation which is a critical variable during the reproductive stage. The soil status of the Kuttanad villages is not quite healthy; they are characterised by excess of acidity and salt content, and deficiency in

*A more detailed analysis of the level and quality of

Table 20: Estimation of Response of Yield to NPK Application

| Village and Season | No. of observations | $R^2$ | Regression Co-efficients of N | P | K | $N^2$ | $P^2$ | $K^2$ | NP | NK | PK | NPK | Const |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Akathethara | | | | | | | | | | | | | |
| (i) Mundakan | 52 | .23 | 5.853 | 35.970 | 12.016 | 0.015 | 0.259 | -0.160 | -0.642* | -0.026 | -0.345 | 0.006* | 180 |
| | | | (0.799) | (1.632) | (1.666) | (0.264) | (0.554) | (1.945) | (2.139) | (0.236) | (1.109) | (2.084) | (5.5 |
| (ii) Punja | 51 | .22 | 16.229 | -31.424 | 11.383 | -0.107 | 0.015 | -0.037 | 0.474 | -0.114 | 0.462 | -0.006 | 165 |
| | | | (1.939) | (0.663) | (0.777) | (1.298) | (0.049) | (0.257) | (0.899) | (0.644) | (0.521) | (0.564) | (6.6 |
| (iii) Virippu | 61 | .25 | 12.031 | -37.586 | 14.094 | -0.100 | -0.060 | -0.137* | 0.372 | 0.027 | 0.148 | -0.001 | 195 |
| | | | (1.748) | (1.513) | (1.310) | (1.843) | (0.241) | (2.505) | (1.295) | (0.233) | (0.421) | (0.302) | (7.6 |
| 2. Thakazhy | | | | | | | | | | | | | |
| (i) Punja | 63 | .14 | 21.352 | -20.289 | -2.738 | -0.117 | 0.039 | 0.064 | 0.194 | 0.029 | -0.226 | 0.001 | 183 |
| | | | (0.860) | (0.900) | (0.204) | (0.796) | (0.139) | (0.683) | (0.580) | (0.170) | (1.258) | (0.130) | (1.0 |
| 3. Kainkary | | | | | | | | | | | | | |
| (i) Punja | 58 | .21 | -4.462 | 6.541 | 32.479 | -0.001 | -0.107 | 0.088 | 0.194 | -0.017 | -0.341 | 0.001 | 165 |
| | | | (0.209) | (0.169) | (1.709) | (0.014) | (0.506) | (1.533) | (0.640) | (0.115) | (1.043) | (0.527) | (1.3 |
| (ii) Virippu | 52 | .26 | 9.230 | 105.48* | 26.909 | 0.066 | -1.135 | 0.101 | -0.199 | -0.332 | -0.604 | 0.004 | 64 |
| | | | (0.267) | (2.054) | (1.260) | (0.225) | (1.407) | (0.838) | (0.273) | (1.092) | (1.068) | (0.766) | (0.1 |

Note: *implies significance at 5% level.

in lime. The soil status of the selected villages in Palghat seems to be better.[22]

(iv) The attack of pests and diseases is perhaps the most serious threat facing the new rice varieties in Kerala, especially so in one of the study areas, viz., Kuttanad. Of late, the gravity of the problem has assumed more serious dimensions - in terms of frequency, scale and extent of damage. While the genesis of the problem can be traced to the environmental conditions, changes in the crop variety, cropping pattern and cultural practices may have contributed to its accentuation. "The warm humid climate prevalent during the cropping season in the tract is congenial for the multiplication and spread of different pests and diseases of rice. The yigh yield environment involving a dense canopy, increased use of nitrogen and other inputs, gave rise to more pests and diseases. In general, the micro-environment beneficial to the crop was all favourable for the pests and diseases."[23] The physiological properties of the new varieties viz., short stem and high tillering rate, provide thick canopy, which in turn increases humidity and temperature in the micro-environment of the plant - an ideal climate for the multiplication of insects. Increased application of fertilizers further enriches the canopy of plants, and thereby the fertility of insects. Photo-insensitivity has destroyed traditional cropping pattern leading to continuous cultivation and, therefore, continuous food supply for the insects. Higher dosages of insecticides in the process

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22/ R.S. Aiyer, and Alice Abraham, "Rice Soils of Kerala", Agricultural College, Vellayani, Trivandrum (unpublished).

23/ "Operational Research Project on Integrated Control of Rice Pests in Kuttanad, Kerala", Kerala Agricultural University and Department of Agriculture, Government of Kerala, Annual Report 1979-80 (unpublished).

have contributed to wiping out all natural enemies of pests such as frogs, insects, fish and to some extent even spiders. It is also observed that in the case of traditional varieties the attack of pests used to be in the early stages of plant growth - the vegetative stage - and did not persist in the later, reproductive, stages; but with HYVs, the pests, because of the continuity in the presence of green matter, persist through the reproductive stage also. Further, it is easier to control pests in the earlier stage and almost impossible to control in the reproductive stage. In the former case there is greater ease of entry into the field for plant protection measures as well as option in the choice of insecticides; in the reproductive stage, the choice of insecticides has to be highly selective. Responding to our query, the sample cultivators with few exceptions, stated that the incidence of pests and diseases has increased after the advent of these new seed varieties.

The main pests that have assumed alarming proportions in Kuttanad in recent years are brown hopper, rice leaf roller, rice stem borer, rice gall flies, and rice bug. It is also significant to note that these pests are not competitive; they have different feeding habits. Whereas the brown hopper would remain at the base of the plant, leaf roller feeds on the leaf lamina, and the stem borer bores into the stem and feeds from within.

A variety of diseases like sheath blight, sheath rot and bacterial leaf blight also pose a threat to the rice crop in the study areas. Admittedly, these are of recent occurrence whose severity gets progressively heightened; and some of the characteristics of HYVs referred to earlier have probably contributed to their genesis and spread.

(v) Another related problem is the intensification of weeds in recent years. The changes in the cropping pattern and cultivation practices mentioned above may have also a bearing on this phenomenon. The fact of the matter is that the situation results in competition between weeds and the dwarf paddy for plant nutrients, moisture, even sunlight.

(vi) The response on the part of cultivators to intensification of pests, diseases and weeds has been the intensification in the application of plant protection materials. The indiscriminate application of the insecticides, pesticides, weedicides, etc. poses serious health hazards and ecological problems, especially so in the Kuttanad regions.

(vii) It is also widely held that rice from the dwarf/semi-dwarf HYVs is inferior compared with that of the traditional and the nationally improved varieties. The difference in the quality is reflected in the lower price of the HYV rice in the local market, as confirmed by the responses to our query from the majority of the sample cultivators. The straw yield of the new varieties is stated to be lower in the experience of a sizeable proportion of the sample cultivators.

## Summary and Conclusions

As of 1978-79, nearly one and a half decade after their introduction, the HYVs had spread to just a little over one-third of the area under rice in Kerala. The yield rate of the new seed varieties, though slightly higher than that of local varieties, does not come anywhere near what is claimed to be their genetic potentialities or realised elsewhere; further the yields are marked by a high degree of fluctuation. The comparatively low yield may have a bearing on the low rate of adoption of HYVs in the State.

On the other hand, the rate of adoption of HYVs by the sample cultivators was found to be quite high. This is not surprising in that the study areas are in two comparatively favourably endowed regions, Palghat and Kuttanad, the traditional rice bowls of Kerala. However, the yield rates of the new varieties on these holdings are also not too high. The yield rates do not show any significant, positive, association with either size of holdings or NPK application. The cultivators in these parts have a comparatively high degree of knowledge, awareness and receptivity to modern cultivation practices. Then, the explanation for the relatively low yield rates of the new varieties may be in the not too favourable physical and environmental conditions. The physical conditions engender an environment conducive to the genesis and spread of pests and diseases. The new rice varieties and the accompanying changes in cropping season and cultivation practices have aggravated the extent and intensity of the attack of pests and diseases.

In this context, it has been pointed out that the semi-dwarf HYVs now in vogue are those bred before 1972 and they have become out-moded and obsolete. HYVs superior to the present ones and possessing the base of the local varieties and the high yielding potential of the semi-dwarf varieties have not been released in Kerala since 1972.[24/]

The spread of the new varieties, as it has occurred in these study areas, has radically altered the situation. Given the environmental conditions, the response of yield to fertilizer is low. The physiological properties of the new seed varieties accentuate the incidence of pests and diseases. The high and rising prices of fertilizer and plant

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24/ Dr. R. Gopalakrishnan in personal correspondence.

protection materials push up the costs of production. Wholesale adoption of HYVs seems to be slowly leading to the total elimination of traditional varieties. All those together would reduce the options before the cultivators. If the foregoing assessment is correct, the rice economy in the study regions is caught in a paradox of modernization with out commensurate improvement in net returns. The future of the HYVs programme would seems to depend upon fresh efforts and breeding new varieties to suit the local conditions and constraints.

Finally, a word of caution: the study pertains to only two regions, Palghat and Kuttanad, and these regions do not represent the spectrum of rice growing situations prevailing in Kerala. The conclusions drawn from the present study are not necessarily applicable to the entire rice economy of the State.

21 December 1981. P.G.K. Panikar

The paper incorporates part of the findings of a study on the adoption of HYVs of rice in Palghat and Kuttanad, two principal rice growing regions in Kerala. The study, jointly undertaken with Professor Jean Mencher, was sponsored by the Indian Council of Social Science Research.

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Appendix Table I: Level and Stability of Yield of HYVs and Local Varieties of Rice

| | Virippu | | | | | | | Munpakan | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % of area in Virippu | % of area Under HYV | Yield rate HYV | Kg./hect. L.V. | Coefficient of HYV | Coefficient of LV | Percent of yield of HYV to that of LV | % of area | % of area under HYV | Yield rate kg./hect. HYV | Yield rate kg./hect. LV | Coefficient of Variation of HYV | Coefficient of Variation of LV | Percent of yield of HY to that of LV |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Trivandrum | 47.77 | 18.43 | 1679 | 1356 | 17.30 | 3.67 | 123.89 | 46.40 | 12.80 | 1593 | 1551 | 15.59 | 6.44 | 102.71 |
| Quilon | 40.12 | 16.40 | 1479 | 1297 | 20.60 | 15.74 | 114.03 | 49.37 | 3.11 | 1457 | 1654 | 14.33 | 6.00 | 88.09 |
| Alleppey | 34.47 | 42.14 | 1791 | 1056 | 20.89 | 16.16 | 169.60 | 34.93 | 61.73 | 2022 | 1025 | 20.84 | 22.26 | 197.27 |
| Kottayam | 35.79 | 63.90 | 1684 | 1240 | 13.99 | 9.90 | 134.94 | 33.07 | 62.41 | 1593 | 1444 | 14.21 | 10.10 | 110.32 |
| Ernakulam | 42.65 | 57.26 | 1570 | 1143 | 10.39 | 6.19 | 130.06 | 39.04 | 4.70 | 1340 | 1349 | 21.54 | 9.09 | 99.93 |
| Trichur | 37.14 | 26.24 | 1439 | 1112 | 15.09 | 13.03 | 129.41 | 47.01 | 21.11 | 1520 | 1265 | 17.59 | 9.25 | 120.16 |
| Palghat | 50.43 | 68.57 | 2282 | 1752 | 13.02 | 8.72 | 130.25 | 47.17 | 16.30 | 1040 | 1366 | 22.79 | 10.09 | 98.61 |
| Malappuram | 47.63 | 16.01 | 1452 | 1020 | 15.69 | 13.51 | 141.25 | 45.33 | 10.00 | 1637 | 1293 | 20.36 | 14.24 | 126.60 |
| Kozhikode | 25.97 | 19.63 | 1033 | 761 | 31.20 | 11.39 | 135.74 | 60.59 | 8.64 | 1713 | 1218 | 24.50 | 6.03 | 140.64 |
| Cannanore | 53.57 | 15.74 | 1477 | 1274 | 21.96 | 9.40 | 115.93 | 37.37 | 11.73 | 1521 | 1299 | 13.30 | 7.50 | 117.09 |
| Kerala | 44.30 | 30.90 | 1778 | 1280 | 10.49 | 5.26 | 130.04 | 44.03 | 19.59 | 1639 | 1453 | 9.40 | 5.40 | 112.80 |

Note: HYV: High Yielding Varieties
LV: Local Varieties
Source: Same as in Table 6.

Appendix Table I (contd...)

| Districts | Punja | | | | | | |
|---|---|---|---|---|---|---|---|
| | % of area in Punja | % of area under HYV | Yield rate (kg./hect.) HYV | LV | Coefficient of variation HYV | LV | % of yield of HYV to that of |
| | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Trivandrum | 5.75 | 66.99 | 1176 | 923 | 15.78 | 20.20 | 121.99 |
| Quilon | 2.01 | 16.51 | 1517 | 1027 | 53.88 | 28.13 | 147.71 |
| Alleppey | 30.20 | 91.29 | 2269 | 1352 | 12.83 | 55.15 | 167.82 |
| Kottayam | 31.14 | 86.63 | 2080 | 1464 | 15.96 | 52.21 | 142.08 |
| Ernakulam | 17.51 | 41.35 | 1505 | 1222 | 24.62 | 17.32 | 123.16 |
| Trichur | 13.62 | 64.99 | 1933 | 1215 | 15.88 | 21.52 | 159.09 |
| Palghat | 2.40 | 57.09 | 2049 | 1143 | 13.93 | 27.63 | 179.27 |
| Malappuram | 6.54 | 81.17 | 2097 | 1415 | 24.20 | 55.93 | 148.20 |
| Kozhikode | 13.94 | 53.98 | 1923 | 1046 | 24.11 | 39.05 | 183.84 |
| Cannanore | 9.06 | 27.87 | 1673 | 1472 | 9.97 | 14.93 | 113.65 |
| Kerala | 11.67 | 67.42 | 2064 | 1383 | 13.27 | 17.49 | 149.24 |