INDIAN INSTITUTE OF SCIENCE
Centre for Ecological Sciences

Effect of Rainfall Variability and Lift Irrigation On Rice Yield In Uttara Kannada : A Case Study Of Unchagi Village.

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January 1987

Technical Report No. 26

ABSTRACT

The effect of rainfall on the first crop's (Khariff) and second crop's (Rabi) rice yield for the Unchagi village of Uttara Kannada for the years 1953 to 1983 showed that there is little correlation between the total rainfall and the first crops yield. There is no secular trend in the total rainfall as well as first crop yield in the last 30 years. There is a positive correlation between the second crop's (Rabi) yield and the rainfall between November and February. There is no secular decline in November-February rain but about 50 percent decline in second crop yield after 1967. The excess water drawn by lift irrigation pumps to areca gardens is found to be the cause for decrease in the second crop rice yield by nearly 50 percent after the years 1968. Percolation tanks, to augment surface water, is a possible remedy suggested.

1. Introduction

Agricultural practices are entirely dependent on rain in the western Ghat regions of peninsular India. Uttara Kannada is one of the Western Ghat districts in Karnataka State; cereal crops is rice, and mostly grown twice a year. The first crops (Khariff) is taken during the June to October and the second crops (Rabi) during November to

March. Due to uneven landscape, there is no river irrigation system and the rice yield is entirely dependent on the total rainfall and its proper distribution. The villages in this district started getting electricity mainly for irrigation pumpsets to plantation gardens in the year 1968. Before this time, traditional 'Yatas' were employed for lift irrigation. It is allaged that water level in the rice field is receeding faster and consequently, the yield during the rabi season is reduced. Farmers of Unchagi village were of firm opinion that reduction in the rice yield is over 50 percent since 1968 due to excess water drawn from open wells through irrigation pumpsets to areca gardens. Also, there was a feeling that the total rainfall is reduced due to denudation of forest around this region. Here we report on the variation in the total rainfall, effect of lift irrigation to the areca gardens on the rice yield taking Unchagi village as a typical example.

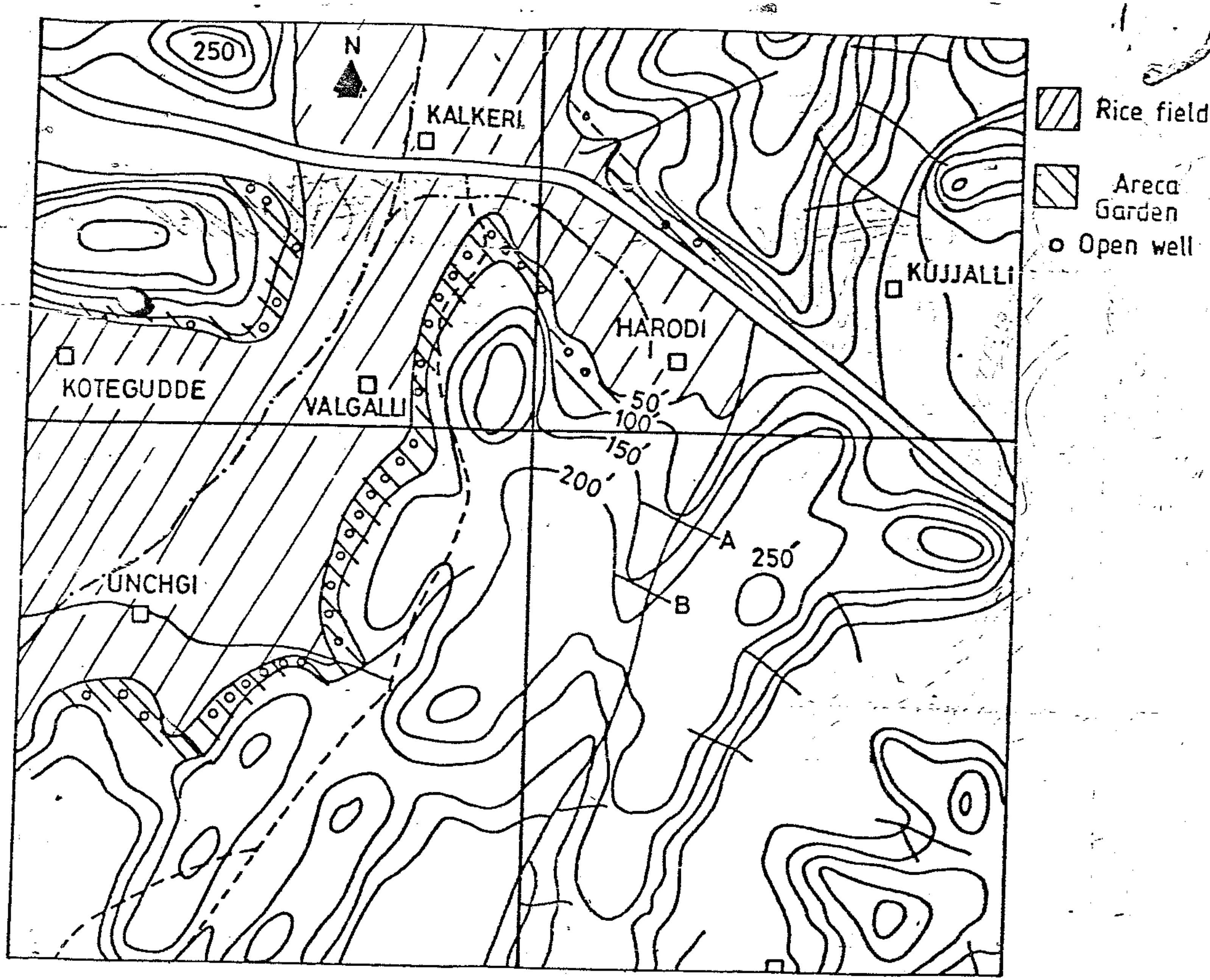
2. Materials and Methods

Unchagi valley, the village under study is situated at $14^\circ 23'$N, $75^\circ 26'$E and it is about 4 kilometers from the nearest town, Kumta. Ground level countours of Unchagi valley surrounded by three villages namely Unchagi, Koteguddo and Valagalli is shown in Fig 1. This is the typical landscape of the Western Ghats region of Karnataka. Average slope of the ground along the valley is about 11-15 percent or $(6-8^\circ)$. The lowest lying land is generally rice field where two crops are grown. In the fields at a slightly higher level 3-5 meters, the first crop is rice but during the second season, black gram, groundnut and vegetables are grown. The rice field is surrounded by sugarcane and plantations of areca and coconut. During the dry season (October to the end of May) these plantations are lift irrigated from open wells. Around the villages one finds forests and grasslands which are largely denuded at present. The approximate locatins of open wells in the plantations, the rice fields and the central canal carrying water during the rainy season have been indicated in Fig.1. Total area under cultivation is about 100 hectares in the Unchagi valley of which rice is raised on 80 hectares. The area is composed of lateritic soils. The top soil can be classified as slit loam and its thickness varies from 10-150 cms. It is underlain by laterite to a depth of about 15 meters after which schists, goeises and granites are encountered. From 1950 onwards there has been a large degradation of the forest land, and top soil in the hills is being continually washed off.

Two families (Mr. Ganapathi Hegde and Mr. Nagu Gowda) had kept records on the rice yield from 1950-1983 for both the crops in Unchagi. Along with the yield records the reasons for high/low yield in a particular year were also recorded. The rice yield records were in local units called 'Khandaga'. One 'Khandaga' is equal to 35 kg in weight Ganapathi Hegde's data was for 0.45 acres and 0.75 acres for first and second crops respectively whereas Nagu Gowda's data was for 1.0 and .5 acres for the first and the second crops. These data were converted to tonnes/ha. Monthly rainfall data for Kumta station was obtained from the Karnataka State Bureau of Economics and Statistics for the years 1950-1983.

3. Results and discussions

Fig.2(a) shows annual rainfall for 1950-1983. The mean annual rainfall is 345.73 ± 76.24 cms implying a high coefficient of variation. The mode is 338.33 cms. In Fig. 2(b), the number of rainy days for 1953-1980 is shown. The mean rainy days is 114 ± 14 days. The test for randomness on annual rainfall (Sokol and Rahlf, 1969) shows that there



250
N
KALKERI
KOTEGUDDE
VALGALLI
HARODI
KUJJALLI
UNCHGI
50
100
150
200
250
A
B
Rice field
Areca Garden
Open well

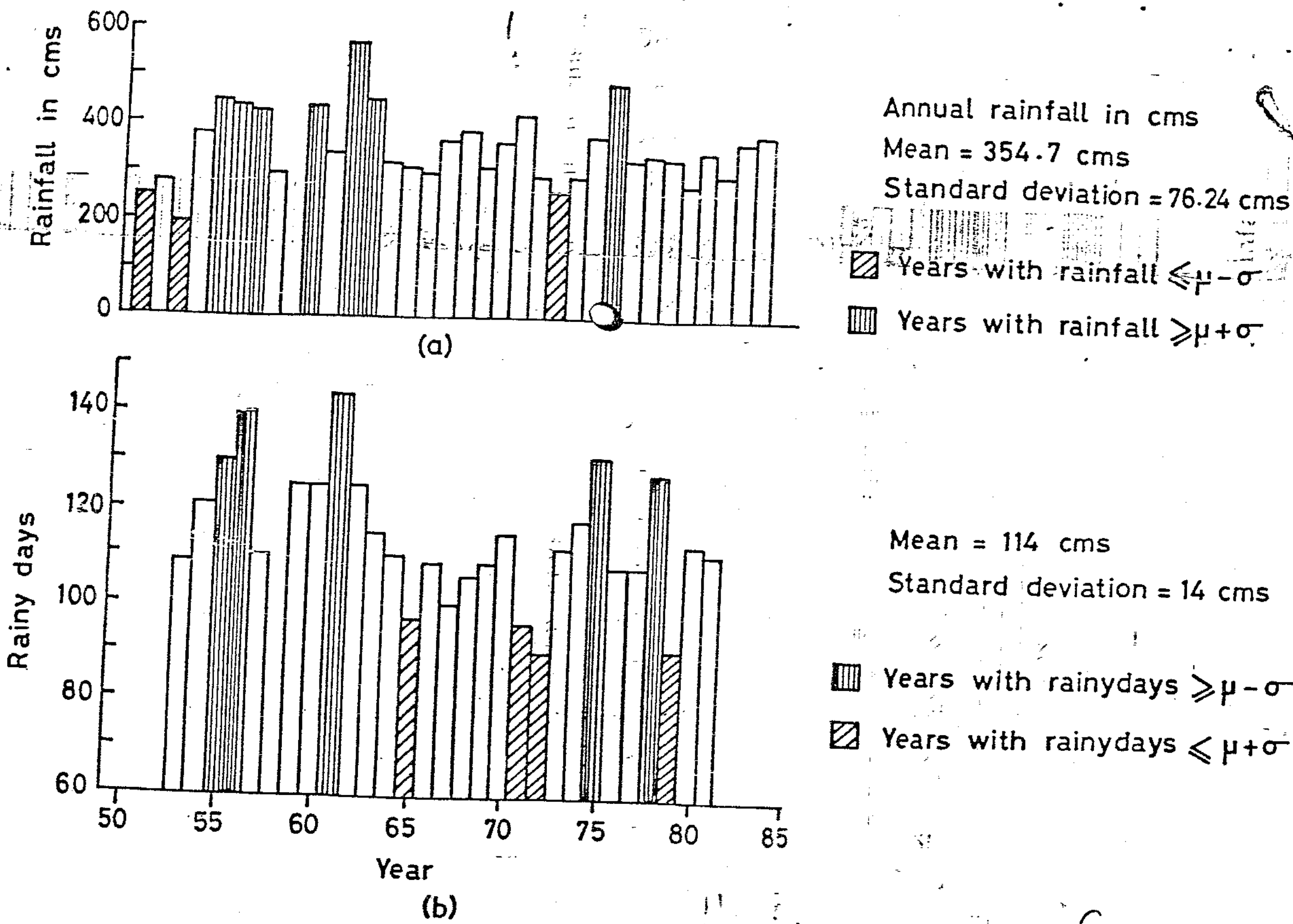

600
400
200
0
Rainfall in cms
(a)
Annual rainfall in cms
Mean = 354.7 cms
Standard deviation = 76.24 cms
Years with rainfall ≤ μ − σ
Years with rainfall ≥ μ + σ
140
120
100
80
60
Rainy days
50
55
60
65
70
75
80
85
Year
(b)
Mean = 114 cms
Standard deviation = 14 cms
Years with rainydays ≥ μ − σ
Years with rainydays ≤ μ + σ

Fig 2

is no secular trend in annual rainfall for these years.

The Fig.3(a) the first crop's rice yield from G.G. Hegde's is shown for the year 1954 to 1980. The mean yield is 2.32 tonnes/ha. This has a coefficient of variation of 24 percent. The I crop's yield for 30 years is correlated negatively to the annual rainfall (Υ = −0.31) as well as to the number of rainy days (Υ = −0.3). These correlations are not significant. The test for randomness of the crop yield has also shown that there is no secular trend (r=14; $\sigma_r - 1.96\sigma_r$, 14, $\sigma_r + 1.96\sigma_r$).

Table 1(a) and 1(b) show the frequency distribution of rainfall and the first crop's yields. It is apparent that the years with low rainfall assure the given average yield. The I crop yield seems to be sensitive to rainfall distribution pattern during the months June-October. Very high rainfall in July (>150 cms) and the sudden drop in August (Ca. 50 cms) do not seem to favour rice. The yield seems to be very sensitive to this fluctuation of rainfall particularly during the years of higher rainfall. As a result reduction in rice yield by 30-40 percent has been observed. In low rainfall years the decrease is only 10-15 percent.

In Fig. 3(b) second crop's yield from G.C. Hegde's field (November-March) is shown for the years 1953 to 1983. It is clear from the figure that there is not a single year before 1967 having yield less than 1.225 tonnes/ha and not a year after 1967 having higher than 0.875 tonnes/ha. Mean yield of second crop for years 1953-1967 is 1.87 ± 0.44 tonnes/ha. From 1968-1983 it has a mean yield of only 1.02 ± 0.42 tonnes/ha. The students test (Sokal and Rolf 1969) show that the two mean are significantly different (p<0.001). The reduction in yield after 1967 is

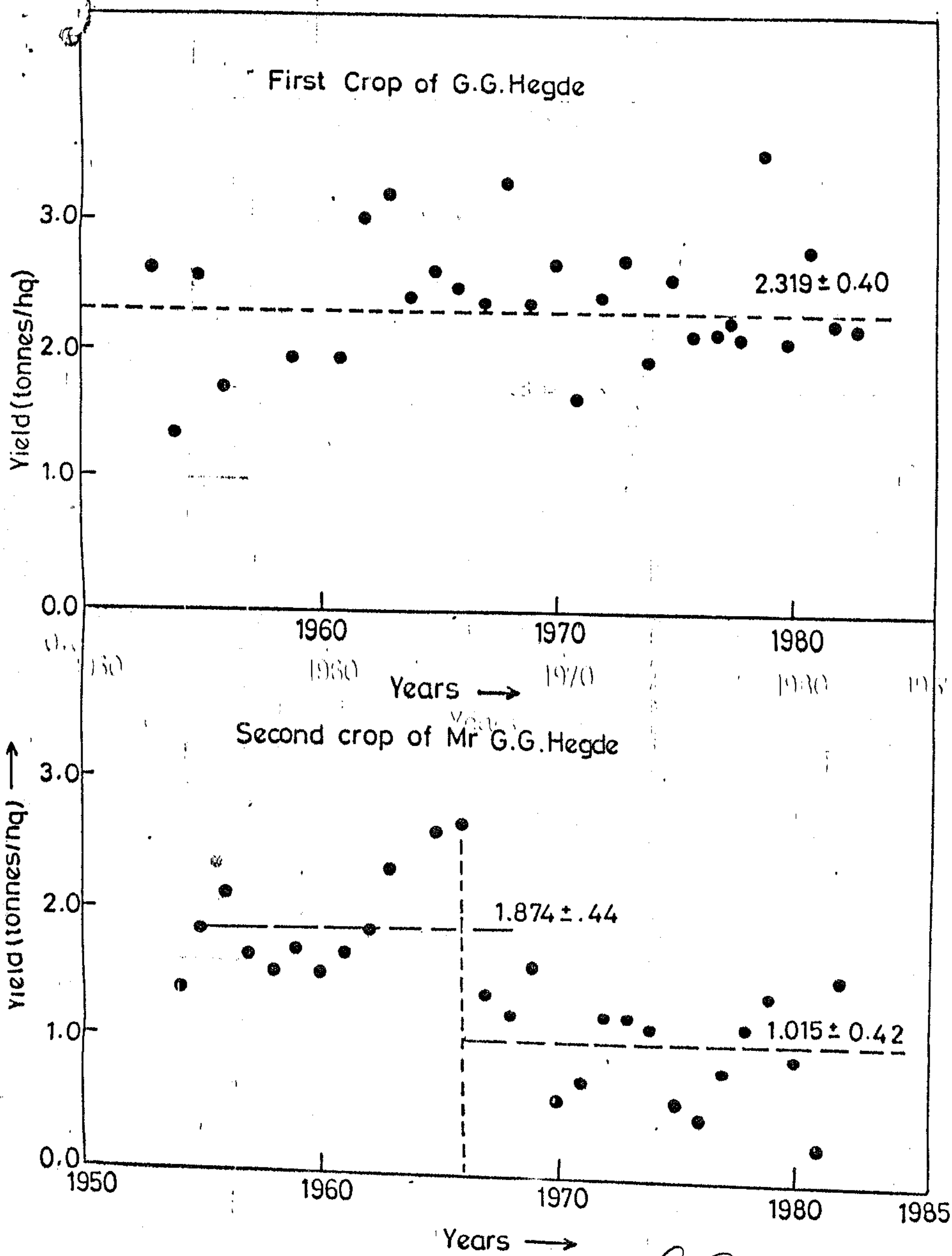

First Crop of G.G.Hegde
Yield (tonnes/hq)
3.0
2.0
1.0
0.0
2.319 ± 0.40
1960
1970
1980
Years
Second crop of Mr G.G.Hegde
Yield (tonnes/hq)
3.0
2.0
1.0
0.0
1.874 ± .44
1.015 ± 0.42
1950
1960
1970
1980
1985
Years

Fig 3

almost 50 percent. There is no drastic change in the total annual rainfall that can explain this variation.

The second crop depends on the surface water available during the months November to March. Fig.4 shows the total rain received and the number of rainy days for the 30 years during the months months November-February. The correlation between II crop yield (from Fig. 3b) the rainfall (from November to March) for the first 15 years is 0.619 (significant at 5 percent) and 0.43 for the 15 years after 1967 (significant at 10 percent). The years 1964-1965 and 1965-1966 had few showers in November, December and January. The rice yield was 2.61 and 2.68 tonnes/ha respectively which is 40 percent more than the average yield (from 1953-1967). Similarly 1978-79 and 1982-83 had about 8-10 cms of rain from November to January. The yield of these years were 1.4 and 1.54 tonnes/ha respectively which is again about 40 percent higher than the mean yield for the years 1968-1983. Notice here that inspite of the total rainfall not being changed, the yield of the Crop II is about 55 percent of the mean yield of the first 16 years.

Although, the data from the second farmer is not complete for all the years, we have shown in Fig.5 the yields of the first and second crops. The first crop's yield does not shown any large variation from 1952 to 1983 (Fig.5(a)), but the second crop's mean yield after 1967 is about 60 percent compared to the years before 1967 (Fig.5(b)). Almost uniform I crops yield and decrease in II crops yield after 1967 thus confirms the crops yield variation seen from the first farmer.

The gross decrease in the second crop's yield after 1967 cannot be explained by any other factor than the less water availability. The two farmers have also confirmed that they have not been using any chemical fertilizers and also the type of paddy grown has remained the same

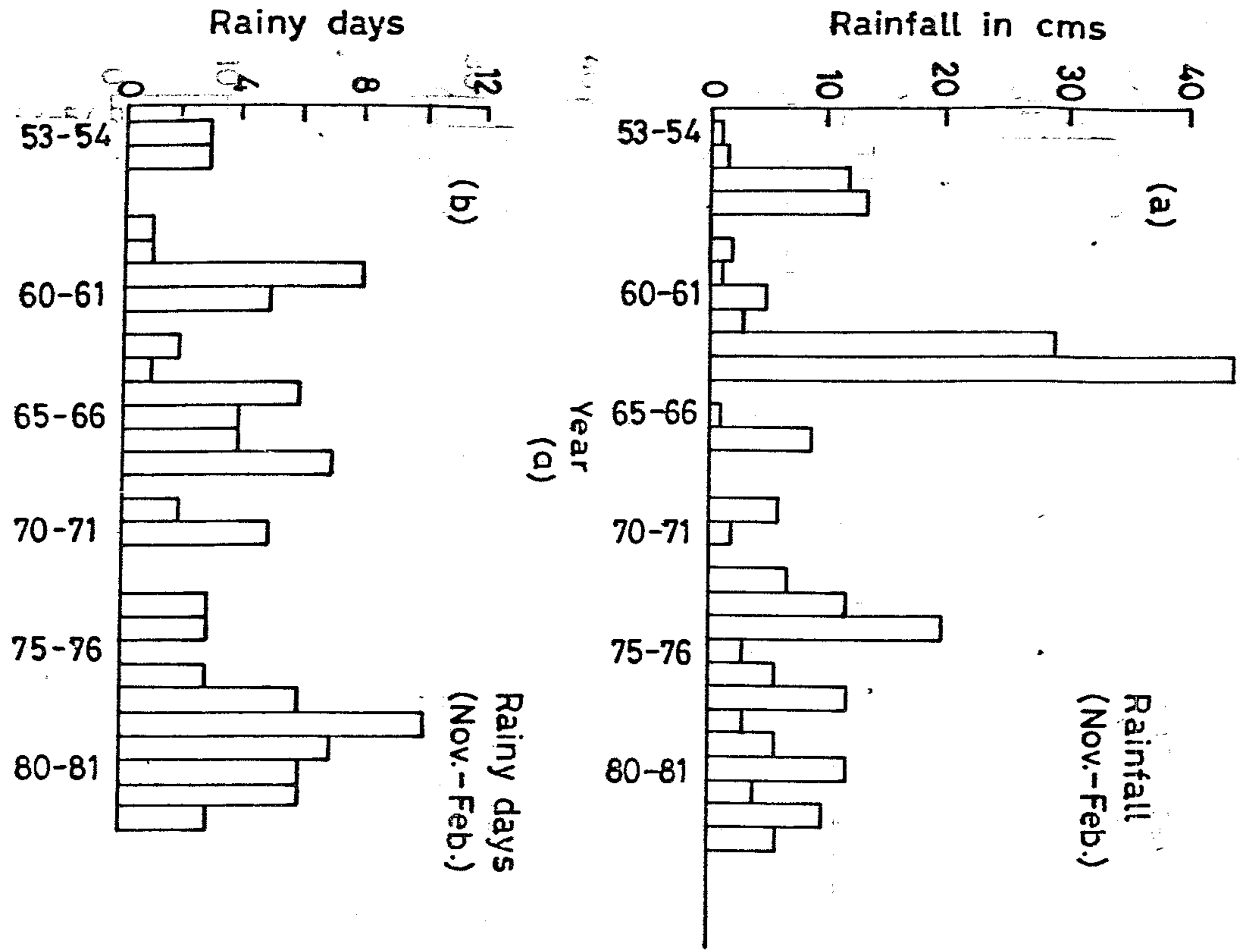
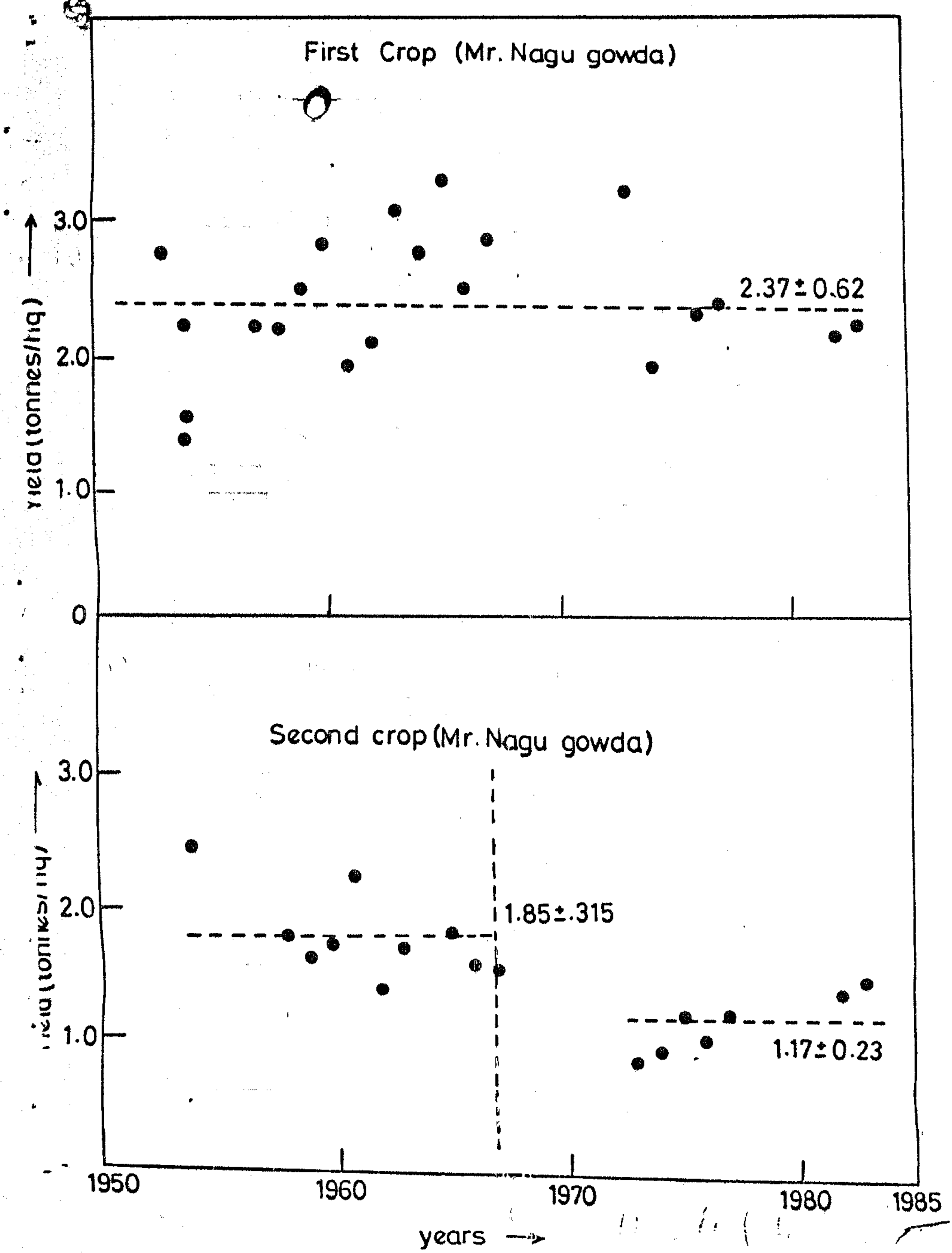

Rainfall in cms
0
10
20
30
40
(a)
53-54
60-61
65-66
70-71
75-76
80-81
Year
(a)
Rainfall
(Nov.-Feb.)
Rainy days
0
4
8
12
(b)
53-54
60-61
65-66
70-71
75-76
80-81
Year
(b)
Rainy days
(Nov.-Feb.)

Fig 4

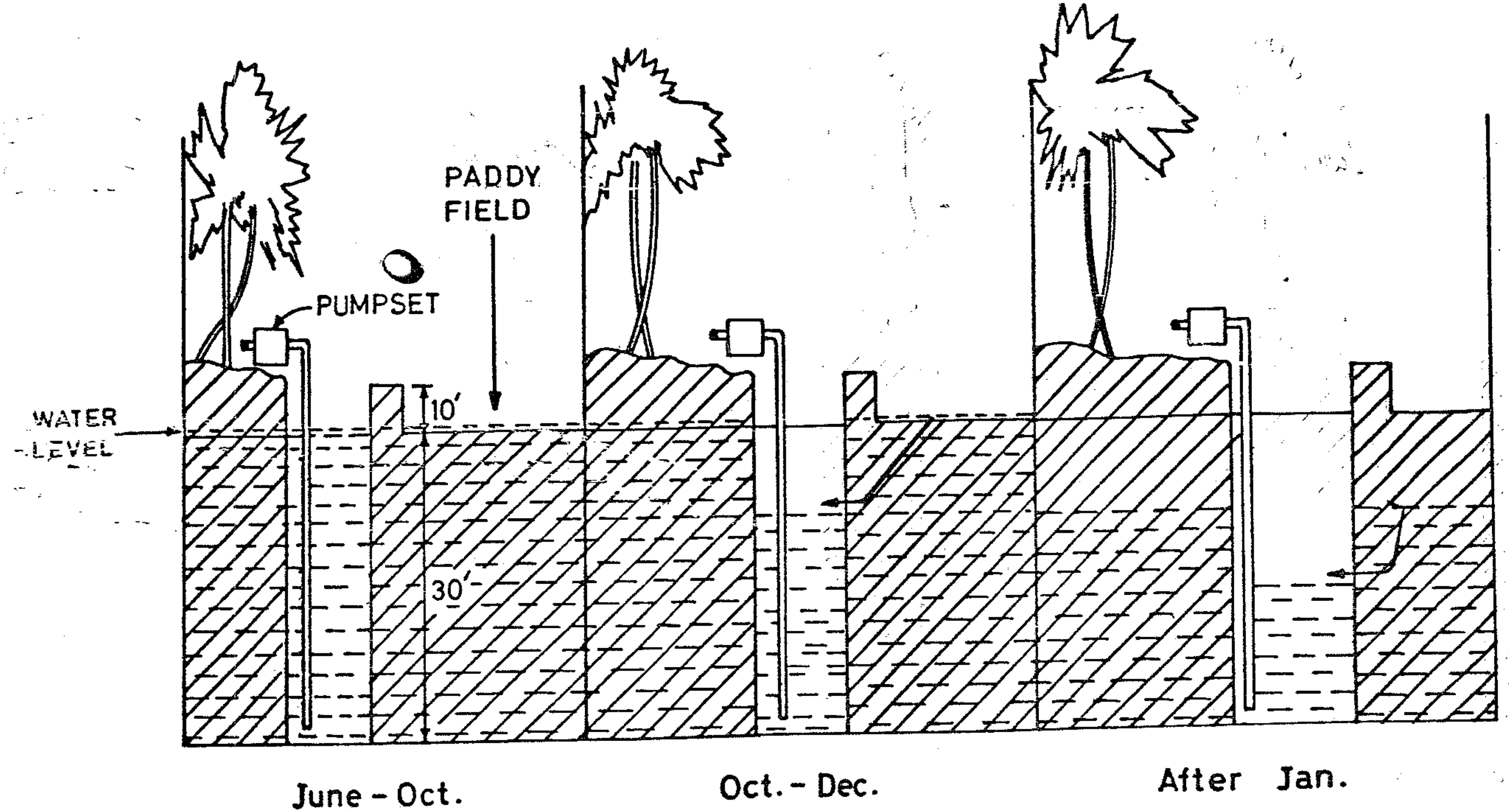

First Crop (Mr. Nagu gowda)
2.37 ± 0.62
Yield (tonnes/ha)
3.0
2.0
1.0
0
Second crop (Mr. Nagu gowda)
1.85 ± .315
1.17 ± 0.23
1950
1960
1970
1980
1985
years

An estimate of water discharge from a 2HP water pump is about 550 to 700 litres/min at a static head of 6 meter and amount of water a man can lift through `yatas´ is only about 50-60 litres/min. Again a human being cannot continue to lift water for more than 2 hours whereas machines can continue for over 8-10 hours. Therefore, even a most conservative estimate shows that the quantum of water lifted from open wells has gone up at least by 10 times than the traditional methods when there is water in the wells. When the water level goes down in the wells, water is replenished through underground percolation from the paddy fields. This can be seen during the months October to February in this regions. This is shown schematically in Fig.6.

The soil being lateritic, lateral percolation of water to open wells is taking place. In fact, while the pumps are on, one can see the underground flow of water from the fields to the wells when there is surface water, the water level in the well is the same as in the rice field dries, water level in the wells drops. Thus, the water level in the rice field is found to deplete faster now compared to the years before 1967 leading to a decrease in the rice yield during the Rabi season.

3.1 Social implications

Further, the field observations suggested that the areca gardens irrigated by means of electric pumps yielded more after 1967. However 70 percent of the farmers holding rice fields do not have any areca gardens. Thus the rice growing farmers have essentially become poorer after 1967. Overall production of rice, which is the staple food of this region, has dropped. Thus the indirect method of draining water


PADDY FIELD
PUMPSET
WATER LEVEL
10'
30'
June - Oct.
Oct. - Dec.
After Jan.

from the rice fields by infilteration into the open wells has further increased the gap between the rich and the poor in this village.

The situation is essentially similar in the neighbouring villages such as Kalakeri, Koojalli, Harodi and Talgod of Kumta Taluk. A discussion with the farmers of Sirsi taluk in Uttara Kannada revealed that here too, due to water scarcity in the rice fields due to excessive usage of irrigation pump sets for areca gardens, they have stopped growing rice during the second season. While one cannot stop individual farmers irrigating the land with electric pumps under the existing rights and law of the land, alternative methods to augment ground water can only help the farmers.

3.2 Percolation tanks:A possible remedy

Rama Prasad and Gangaraju(1983) have studied the possibility of recharging ground water through percolation tanks. The study was carried out for the village Unchagi, Valagalli and Harodi. They have suggested a percolation tank to be built across the Harodi hills, 50 feet higher than the rice fields level. The study has shown that storing only about 10 percent of the rain water across the Harodi ridge should be enough to provide sufficient water for rice growth in the second season.

A farmer of Bhairumbe (Sirsi) has built a percolation tank on his won in 1979. The size of the tank is about 0.4 ha. With this, 4 ha coconut garden below the tank area is cultivated without providing any water by way of lift irrigation. Thus, this concept seems to work. No canal irrigation system is possible due to the uneven landscape. This region of Karnataka receives the highest rainfall. Therefore, augmenting ground and surface water by storing rain water uphill in the natural valleys seems to be an ideal solution.

4. Conclusions

From the analysis of rainfall from 1953-1983 and first and second crop rice yields we find that:

a) there is no secular trend in the total rainfall during these 30 years

b) there is no secular trend in the I crop rice yield between 1953 to 1983

c) there is no significant correlation between the first crop rice yield and the total annual rainfall

d) the second crop yield and rainfall from November to February is positively correlated and

e) the decrease in the II crop rice yield after 1967 due to irrigation pumps to water areca gardens is about 50 percent.

Acknowledgement

The authors thank Mr. Ganapati Hegde and Mr. Nagu Gauda, Unchagi for giving the crop yield data. Thanks are due to Professors Madhav Gadgil for help discussions and to Mr. Ranjit Daniels for useful suggestions.

References

1. .Ramaprasad and Gangaraju, S.A. (1983) Ground water recharge through percolation tanks in Karnataka, Karnataka State Council for Science and Technology Report.

2. Sokal R. R. and Rogil F. J. (1969) Biometry W.H. Freeman and Co. Sanfransisco pp 726.

Captions for Figures

Fig.1 : Contour map of Unchagi Valley.

Fig.2 : (a) Rainfall (b) Rainy days for Kumta taluk from 1953 to 1983

Fig.3 : (a) First crop rice yield for the years 1953 to 1983

(b) Second crops rice yield

Fig.4 : (a) Total rainfall

(b) Number of rainy days between November to February through the years 1953 to 1983

Fig.5 : First and second crop yield for Mr. D[illegible]gu Gauda's farm through the years of study

Fig.6 : Schematic diagram of depletion of surface water due to underground percolation.

Table 1(a) : Frequency distribution of rainfall for 30 years

Rainfall in Cms	No. of years	Years
251 - 300	6	1965,71,72,73,79,81
301 - 350	9	1957,60,63,64,68,76, 77,78,80
351 - 400	7	1953,66,67,69,74,82,83
400 - 450	5	1954,56,59,62,70
> 450	3	1952,61,75

Table 1(b) : Frequency distribution of first crop's for 30 years yield from G.G. Hegde's field

Yield in (tonnes)	No. of years	Years
.71 - .9	1	1954
1.11 - 1.3	9	1957,58,61,74,76,77, 78,82,83
1.31 - 1.5	10	1953,55,60,64,65,66, 67,69,72,75
1.51 - 1.7	3	1970,73,81
1.71 - 1.9	3	1962,63,68
1.91 - 2.1	1	1979