A TECHNO-ECONOMIC ANALYSIS OF POTATO CULTIVATION IN THE NILGIRIS DISTRICT OF TAMIL NADU

Thesis submitted in part fulfilment of the requirements
for the degree of **Master of Science (Agriculture)**
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Agricultural University, Coimbatore

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CERTIFICATE

This is to certify that the thesis entitled **"A TECHNO-ECONOMIC ANALYSIS OF POTATO CULTIVATION IN THE NILGIRIS DISTRICT OF TAMIL NADU"** submitted in part fulfilment of the requirements for the degree of **MASTER OF SCIENCE** (Agriculture) **IN AGRICULTURAL ECONOMICS** to the Tamil Nadu Agricultural University, Coimbatore is a record of bona fide research work carried out by **Miss.PREETHI MENON** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

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To my parents ....

With love

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(PREETHI MENON)

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CHAPTER I

INTRODUCTION

Agriculture represents one third of India's gross domestic product-the highest proportion in the developed and developing world. Without doubt it will continue to be the backbone of the economy for the years to come. Advances in agricultural technology have contributed substantially to increased production during the past four decades The foodgrain production has increased almost 3.5 times from about 50.00 million tonnes to 180.00 million tonnes in 1992-93. Since 1951, the yield of wheat and potato has gone up by seven times, maize by four times and rice, sugarcane, cotton and sorghum by three times. Such a substantial progress could be attributed to the sound planning and matching investment in crop science research in India alongwith an effective network of agricultural extension.

Indian population is likely to touch one billion mark by the end of the century. Then its requirements would be about 230 million tonnes of foodgrains, nine million tonnes of edible oil, 13 million bales of cotton and 11 million bales of jute and mesta. In general, there is need to meet the country's requirement on a sustainable basis to enter the second Green Revolution phase and the post GATT situation. Therefore time has come to look into the supply position of agriculture in the near future. In this regard, concentration on cereals must give way to a better understanding and usage of a range of food sources.

Tuber crops are the most important food crops to be considered after cereals. They form the staple food of more than six per cent of the world's population and for a much higher percentage of population they form the secondary staple. In general, tuber crops are characterised by certain inherent and unique advantages in production. Firstly, they are the most efficient producers of carbohydrates as compared to all other cultivated crops. Secondly, they can be grown even under adverse soil and climatic conditions. Thirdly, these crops are essentially small farmers' crop providing ample opportunities for gainful employment and income in the rural areas.

Among the different tuber crops, potato is the most important one and it is being produced in 130 countries of the world. The details of area, production and productivity of potato for some of the major growing countries in the world shows that India ranks fourth in area and fifth in production of potato with the yield marginally higher than the world average. Potato has unique advantage not only because of its nutritional superiority but also because of its ability to fit well in the various cropping systems in vogue in India. Besides potato is perhaps the only food crop in the country that offers vast scope for augmenting food production and income as well.

Although the productivity level of 16 tonnes per hectare is marginally better than the world average, India has been comfortably placed with respect to the annual growth rate of area, production and productivity of potato as compared to other countries of the world. As against the world compound growth rates of 0.13, 0.85 and 0.72 per cent for area, production and productivity respectively, the corresponding growth rates for India are 3.59, 6.17 and 2.49 per cent respectively. Further, in contrast to the European countries where potato is grown under long day conditions, in India it is grown under short day conditions. Accordingly, if one could compare potato production per unit time and area basis, India, naturally has an edge over Western countries[1].

Among the potato growing states in India, Uttar Pradesh has the largest area under potato with an area of 3.59 lakh ha and production of 66.13 lakh tonnes. Tamil Nadu ranks 15th in area under potato and 11th in terms of production. However, in terms of productivity, Tamil Nadu ranks first with a productivity of 227.4 quintals per hectare[2].

Potato is grown in Tamil Nadu, in an area of 4911 ha spread over mainly in the Nilgiris, Dindugal Anna and Dharmapuri districts. Of these, the area under potato is the highest in the Nilgiris District (2659.00 ha) followed by 2100.00 ha in Dindugal Anna district and 152.00 ha in Dharmapuri district[3].

Potato also contributes significantly to the national economy. Its contribution to the total value of output of agriculture has

[1]V.L. Chopra, "National Symposium on potato-Present and Future" Potato (Shimla : Central Potato Research Institute, 1994) p.3.

[2]Indian Potato Association and Central Potato Research Institute "National Symposium on Strategies for Potato Production, Marketing, Storage and Processing" (Shimla : Central Potato Research Institute, 1990), p.25.

[3]Government of Tamil Nadu, "Season and Crop Report of Tamil Nadu 1991-92) (Madras : Department of Statistics, 1992) p.98.

increased from 1.38 per cent in 1970-'71 to 1.83 per cent in 1990-'91.

In contrast, though rice and wheat formed the major components of Green Revolution and occupied 22.67 per cent and 11.00 per cent of the total cropped area in 1970-'71 respectively, they contributed only 26.22 per cent and 10.68 per cent respectively to the total value of output from agriculture. The performance of these two crops since 1970-'71 has not shown substantial improvement as compared to potato crop. In 1990-'91 while potato accounted for 0.54 per cent of the total cropped area, it contributed nearly two per cent of the total value of output from agriculture. Rice and wheat taking into consideration of their area and production, their contribution to the total value of output from agriculture is far from satisfactory. Besides, the growth rates in area, production and yield for potato is the highest as compared to wheat and rice.

In the period from 1967-68 to 1989-90, the compound growth rates of area, production and productivity of potato are 3.56, 6.64 and 2.97 per cent respectively. In comparison, the compound growth rates of area ,production and productivity of wheat are only 1.91, 5.12 and 3.14 per cent while for rice the same is -0.10, 1.15 and 1.26 per cent respectively[4].

Further, potato produces more food per unit area and time. Both the dry matter and protein per hectare per day is also considerably more in potato as compared to rice and wheat. The

[4]K.L. Chadha, "Potato a future food crop of India", Journal of Indian Potato Association, 21(1&2): 7-20, 1994.

yield of energy and protein from potato is 678 KCal and 176 KCal respectively. In comparison, the food energy obtained from wheat, rice, maize and soybean were 394, 688, 458 and 525 KCal respectively[5].

Potato cultivation in the Nilgiris

Potato was first introduced into Udhagamandalam in the Nilgiris by John Sullivan, an Englishman in 1822. The Botanical Gardens, Udhagamandalam gave a boost to its cultivation in this region in 1848 by supplying seed to cultivators. By 1876 potato was being grown in about 300 ha. The area under potato reached its peak to 10000 ha in 1980's but in recent years potato has been replaced by tea, crops like carrot, cabbage etc., bringing down the area under potato to 3000 ha.

In 1958, the Government of India started a Regional Research Station of Central Potato Research Station, Shimla with the main aim of breeding new potato varieties resistant to pests and diseases. With liberal aid from the Federal Republic of Germany, the Indo-German Nilgiris Development Project, Udhagamandalam, commenced its activities in 1967. The primary aim was to increase production of potato by tackling the problem of golden nematode of potato, enlargement of marketing facilities and developing new potato cultivars for diversification of cropping pattern of the district. Besides these, the Horticulture Department, Udhagamandalam has started a potato development scheme. Under this

[5]K.L. Chadha, op. cit, p.10.

scheme, multiplication of quality potato seeds in Government farms as well as in farmers' holdings is being carried out and distribution to a tune of 200 metric tonnes are being made every year.

In spite of all this, large variations in yield are seen among different categories of potato farmers notwithstanding the declining area under potato. Under these circumstances, it is absolutely essential to trace the causative factors for the decline of area under potato and ways to arrest such drastic decline atleast in the years to come. Further, it was found that the yield of potato in the experimental station ie., the University research station, Udhagamandalam, is 71.8 t/ha as against 15.6 t/ha in the potato growers farms. The constraints for this yield gap may be technical and socio-economic. An analysis of the factors responsible for the yield gap would help to prioritise research investment in potato.

Hence, an attempt has been made in the present study to find out the reasons for declining area under potato and constraints for the yield gap prevalent in potato. It is hypothesised that there exists vast potential to improve the yield of potato in the Nilgiris district.

OBJECTIVES

The overall objective of the study is to study the trend in area, production and productivity of potato in the Nilgiris district and delineate the determinants of yield gap among the potato growers' and progressive farmers. The specific objectives of the study are:

i) to analyse the trend in area, production and productivity of potato in the Nilgiris district;

ii) to study the fluctuations in area under potato at farmers level and to isolate the factor (s) for the same; and

iii) to study the yield gap of potato and constraints associated with it.

SCOPE OF THE STUDY

A study of this kind would help in identifying the technical and socio-economic constraints responsible for the yield gap. This would also help the policy makers and administrators to formulate appropriate policy packages for reducing the constraints responsible for yield gap in the study region.

LIMITATIONS OF THE STUDY

The study was conducted with a set of potato cultivators and progressive farmers in Udhagamandalam taluk of the Nilgiris district. The respondents have furnished the required information for the study from their memory resulting in recall bias. However, efforts were made to minimize the error by cross-checking. Moreover the study pertains to the particular region only. Hence generalisation to other areas must be taken with great care and caution.

ORGANISATION OF THE THESIS

The study has been divided into the following chapters to cover the objectives contemplated

Chapter I	Identifies the problem of research and specifies the hypothesis, objectives, scope and limitations of the study.
Chapter II	Gives a review of related concepts and past studies on the subject.
Chapter III	Specifies the sampling design, method of data collection and tools used in the conduct of research and analysis of data.
Chapter IV	Defines the general characteristic features of the study area and infra-structural facilities available therein.
Chapter V	Gives the results of the study with discussion.
Chapter VI	Summarises the study, provides conclusion and policy options.

CONCEPTS AND REVIEW

CHAPTER II

CONCEPTS AND REVIEW

A review of earlier studies on yield gap and its determinants and related aspects is useful to define the concepts used in this study unambiguously and to formulate hypotheses and model for the study. Therefore, concepts of growth rate, productivity and yield gap is presented in what follows. A review of past related studies is also presented.

GROWTH RATE:

The normal statistical procedure to obtain a measure of growth of area and production of crops over the period is to postulate a hypothetical function, which would adequately describe the series of area and production over time and to estimate its parameters, which would offer a measure of growth over the period.

Growth rates are expressed in two forms viz., linear and compound. The linear form is obtained by fitting a straight line to the index numbers, finding the slope of the line, standardising it, reducing it to a percentage by dividing it by the average index in the first three years. The compound growth rate is obtained by fitting a straight line to the logarithms of the index numbers, the slope of that line gives the constant percentage rate at which the fitted line is changing[1].

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[1]George Blyn, "Measurement of growth rates in agriculture", Indian Journal of Agricultural Economics, 22(2) : 25, 1967.

Growth rates can either be arithmetic or geometric. The arithmetic (or simple) growth rate can be expressed in either absolute terms or in percentage terms, while the geometric (or compound) growth rate can normally be expressed in percentage terms[2].

In this study, area, production and productivity of potato in Nilgiris district was studied by resorting to Gompertz growth rate analysis taking into consideration of the behaviour of the attributes.

PRODUCTIVITY:

Production and productivity are the terms often used to mean the output from a production process. However, as a measure of efficiency of resource use, productivity is considered to mean the output per unit of the resource in question while production is taken as the aggregate output from a given amount of resource used.

Heady defined productivity as the quantity of output turned out in a farm[3].

According to Saxen, productivity can be defined as the ratio of total output to all inputs including intermediate products[4].

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[2] R. Dayal, "Agricultural growth rates and their components", Indian Journal of Agricultural Economics, **21**(3) : 227, 1966.

[3] Earl.O. Heady, "Returns to scale and farm size-Economics of agricultural production and resources use", Journal of Farm Economics, **34**(2): 348-381, 1952.

[4] G.E.A. Saxen, "Special concepts of productivity", National Productivity Council Journal, **6**(2&3): 226-235, 1965.

Lal defined productivity as a measurable relationship between well defined inputs and output in a given period of time[5].

According to Ruttan, the measure of productivity or efficiency of a particular activity would be an evaluation of the output of the activity in relation to the total set of inputs or cost elements required to achieve the objective[6].

Radhakrishna defined productivity as a relationship between inputs and outputs in agriculture[7].

Productivity can be classified into gross average productivity and residual average productivity.

Gross average productivity can be computed for any input for example, for labour, by dividing the total productivity of labour used (or returns) by the number of units of labour used. Residual average productivity of labour can be computed by deducting the value of non-labour services from the total value of output and then dividing the residual by the mandays of labour units used[8].

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[5]B.B. Lal, "Studies on relationship between production results and agents in financial and physical returns", Indian Journal of Agricultural Economics, **43**(1): 45-51, 1968.

[6]W.Vernan Ruttan, "Production economics for agricultural development", Indian Journal of Agricultural Economics, **23**(2): 1-14, 1968.

[7]S.Radhakrishna, "A Study on regional productivities of agricultural inputs", Indian Journal of Agricultural Economics, **19**(1): 237-242, 1964.

[8]S.Kombairaju, "Studies on the economics of production of chrysanthemum and jasmine flowers in Periyanaickenpalayam and Sarkarasamakulam blocks of Coimbatore district", (Unpublished M.Sc(Ag). thesis submitted to the University of Madras, 1970) p.17.

Sivakumar[9] and Puttuswamy[10] also used the concept of gross average productivity and residual average productivity on the lines indicated above.

Bhattarcharjee defined the term productivity as the output per unit of input in farm business[11]. Kargaonkar defined the term productivity as the ratio of output to inputs[12].

Gowar viewed that productivity would normally measure the efficiency with which the inputs were transformed into output[13].

Sangha defined productivity as the ratio between output and input both measured in real terms[14].

Ghouse viewed productivity as the ratio of output to input which could be an indicator of cumulative effects of the economic activity[15].

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[9]A.Sivakumar, "Economics of production and marketing of vegetables (tomato, brinjal) in Tiruchirapalli, (Unpublished M.Sc(Ag). thesis submitted to Tamil Nadu Agricultural University, 1981) p.20.

[10]N.Puttuswamy, "Economic analysis of production and marketing of potato in Ootacamund taluk of the Nilgiris district, Tamil Nadu", (Unpublished M.Sc(Ag). thesis submitted to the University of Madras, 1970) p.16.

[11]J.P.Bhattacharjee, "Resource use and productivity in world agriculture", Journal of Farm Economics, **37**(1): 57-71, 1975.

[12]M.G.Kargoankar, "Productivity : A System Approach", Productivity, **18**(1): 13-21, 1977.

[13]Allan Gowar, "Productivity in Canadian Agriculture", Canadian Journal of Agricultural Economics, **28**(2): 94-95, 1980.

[14]Kekar Sangha, "Productivity and Economic Growth", (Bombay: Asia Publishing house, 1964) p.10.

[15]Ghulam Ghouse, "Comparative measures of productivity-Agriculture vs Industry", Financing Agriculture, **6**(1): 22, 1974.

Acharya[16] and Singh[17] viewed land productivity in terms of yield per hectare of land cultivated.

According to Pandya agricultural productivity indicates how far every unit of input could yield maximum output for improved variety of seeds, irrigation water, fertilizers, herbicides and insecticides[18].

Anbalagan defined productivity as net output per unit, the unit being hectare of land or manday of labour or rupee of investment[19].

According to Acharya and Nair productivity was the contribution of all inputs, they being combined in some composite fashion[20].

Saini argued that land productivity was the output per unit of land[21].

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[16] S.K. Acharya, "Agriculture in Meghalaya, Mizoram, Mikir and Cachar hills", Arthavijana, **16**(1): 50-77, 1974.

[17] Jwala Prasad Singh, "Productivity of crops in Indian agriculture", Productivity, **18**(1): 1-5, 1977.

[18] A.C. Pandya, "Impact of farm mechanisation on agricultural productivity", Productivity, **18**(2): 245-248, 1977.

[19] N.G. Anbalagan, "Study on farm mechanisation and resource use efficiency in Gudiyattam taluk, North Arcot district", (Unpublished M.Sc(Ag) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1977) p.16.

[20] S. Acharya and N.K. Nair, "Empirical issues in total productivity measurement-An experiment with cement industry in India", Productivity, **19**(3): 365-374, 1978.

[21] G.R. Saini, "Farm size, productivity and some related issues in Indian agriculture : a review", Agricultural Situation in India, **34**(11): 777-783, 1980.

According to Singh productivity is the outflow per unit of resource (input), an outcome of the interaction of the mutually reinforcing forces of agrarian structure, resource endowment and technology[22].

Jadhav viewed productivity per unit area as an important aspect in sugarcane cultivation. According to him, to meet the demand for raw materials of sugar factories and jaggery industry, increase in yield per unit area is necessary besides increase in area[23].

Haksar defined productivity as a function of systems and procedures, technology, business planning, attitudes, commitment and knowledge[24].

Swaminathan defined productivity as output value divided by input value multiplied by changes in environmental capital stock[25].

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[22] Baldev Singh, "Productivity and resource structure-A case of agricultural development of Gujarat", Indian Journal of Agricultural Economics, **35**(3): 34-50, 1980.

[23] G.Mohan Jadhav, "Productivity of sugarcane", Sugarcane Cultivation-A Regional Survey, **40**(3): 83-89, 1984.

[24] Ajit Haksar, "Productivity issues and trends", Modern Management, **4**(2): 3, 1987.

[25] M.S. Swaminathan, "Ensuring ecological security", in The Hindu Survey of Indian Agriculture (Madras : National Press, 1989) p.18.

Santhi[26] and Umamaheswari[27] defined productivity of land as output in kg/ha of land.

Sumathi defined productivity as the ratio of total yield to all inputs used[28].

In the present study productivity was defined as yield of potato crop in kg/ha.

YIELD GAP

Varieties of crops released by the research stations ensure a certain assured level of yield under ideal conditions and crop practices. But the agro-climatic conditions in farmers fields are far from ideal. There are also several attitudinal, social, institutional, economic and physical constraints that would prevent farmers' from practising recommended crop practices. Obviously therefore, there existed a gap between actual yield of the crop realized by farmers in their field and the yield that can be obtained in ideal situation. This gap is called yield gap.

Herdt and Wickham defined the gap as the difference between the yield potential at the experiment station during the dry season

[26] S.Santhi, "Comprehensive crop insurance scheme in Agastheeswaram block of Kanyakumari district- An Economic Appraisal" (Unpublished M.Sc(Ag.) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1991) p.17.

[27] L.Umamaheswari, "Yield gap of principal crops in Palani taluk, Dindugal Quaid - E-Milleth district", (Unpublished M.Sc(Ag.) thesis submitted to Tamil Nadu Agricultural University, Madurai, 1990) p.16.

[28] P.Sumathi, "An economic analysis of production and marketing of grapes in Thondamuthur block, Coimbatore district" (Unpublished M.Sc(Ag.) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1992) p.20.

in a good year and the average national yield. They partitioned the gap into year-to-year yield variation, seasonal effects (dry and wet), water control, economic constraints, lack of availability of inputs and non-adoption of technology[29].

Evenson found that the introduction of new technology created a yield gap which he referred to as 'economic slack'. Economic slack would be the difference between the present product of a sector and the product that could be realised if all resources were optimally utilized. According to him, research activities produced slack and it could be reduced by such factors as expansion of extension activities and improvement in rural infra-structure, the incentive for such changes being access to more productive technology. He pointed out that such changes, however, would not occur immediately and it was the delay in or constraints to the process of change that would result in a gap between the actual and potential yield in the farmers field[30].

Gomez developed the conceptual model of yield gap. The difference between experiment station yield and actual farm yield was referred to as yield gap. Instead of comparing the actual farm yield directly with the experiment yield he introduced a yield level intermediate between the above two. That yield level is called potential farm yield and is the yield obtainable in a

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[29] R.W. Herdt and T. Wickham, "Exploring the gap between potential and actual rice yields in the Philippines", Food Research Institute Studies, **16**(2): 163-181, 1975.

[30] R.E. Evenson, "Agricultural research and extension in India", A Survey report for Asian Agricultural Survey, (Manila : Asian Development Bank, 1976), p.25.

farmers field from improved technology. Thus he divided the yield gap into two components, Yield gap I and Yield gap II. The difference between experiment yield and potential farm yield represented Yield gap I, while the difference between potential farm yield and actual farm yield represented Yield gap II[31].

Parthasarathy and Prasad opined that yield gap was the difference between the yields of the best farms, best villages or best districts and the average or poorest farm yields[32].

Barker argued that there was no assurance that these sub-optimal practices used in the experiments, accurately simulated the farmer's practices and therefore, there was no assurance that the gap being measured is in fact the gap between actual and potential yield[33].

Swaminathan identified three types of yield gap namely, gap I, gap II and gap III in wheat crop. According to him, the gap between the yield possible on theoretical considerations and the best yield so far achieved can be referred to as gap I which represented "Research gap". Gap II which can be referred to as "Research-cum-management gap" is the the gap between the best yield

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[31]Kwanchai.A.Gomez, "Basic concepts, objectives and approach", Constraints to High yields on Asian rice farms : An Interim Report, (Manila : International Rice Research Institute, 1977), p.1.

[32]G.Parthasarathy and D.S. Prasad, "Farm level constraints to high rice yields in Asia, 1974-'77 (Manila : International Rice Research Institute, 1977), p.13.

[33]Randolph Barker, "Adoption and production impact of new rice technology-the yield constraints problem" in Farm level constraints to high rice yields in Asia : 1974-77 (Manila : International Rice Research Institute, 1977), p.16.

obtained in the research farm and progressive farmers yield. Gap III is the difference between the best yield realised by a farmer in a state and the state average yield. The third gap can be also called "Extension gap"[34].

In another approach, Mukherji defined yield gap as the ratio between the potential yield as found in national demonstration in a given state and the average state yield[35].

Fale, Thakare and Borude argued that yield obtained at experiment station cannot be achieved on farms because of differences in environment, inputs usage and management. Therefore, they defined yield gap as the difference between the potential yield (i.e., yield obtained in the demonstration plots) and actual farm yield. They defined potential yield as the yield that could be obtained in farmer's field by adopting improved technology[36].

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[34]M.S.Swaminathan, "Improving crop and animal productivity", Indian Farming, **26**(10): 3-5, 1977.

[35]D.K.Mukherji, "Estimate of the gap analysis, value or ratio of National demonstration plot yield to the average state yield, India" in Farm level constraints to high rice yields in Asia : 1974-77, (Manila : International Rice Research Institute, 1977), p.10.

[36]J.B.Fale, G. Thakare and S.G. Borude, "An economic analysis of yield gap in rice in Ratnagiri district", Agricultural Situation in India, **39**(12): 925-930, 1985.

Basavalga[37], Sarup and Pandey[38], Pughazhendi[39] and Ranganathan[40] followed the same concept to measure the yield gap.

Parthasarathy divided the total yield gap conceptually into two parts viz., gap I representing the difference between experimental station yield and potential farm yield (minikits) and gap II indicating the difference between potential and actual yield at the farm level[41].

For Vasanthakumar and Selvaraj, the gap between the on farm yield and potential yield expressed in percentage was the yield gap[42].

Pandey and Tewari divided yield gap into:

i) research level yield gap-the difference between the potential yield as determined by the genetic production potential and

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[37]H.Basavalga, "Yield gaps and constraints in cotton production in Karnataka- An econometric analysis", (Unpublished Ph.D. dissertation submitted to University of Agricultural Sciences, Dharwad, 1988), p.12.

[38]Shanthi Sarup and R.K. Pandey, "Assessment of regional variations in yield gaps of wheat crop in India", Agricultural Situation in India, **36**(8): 623-627, 1981.

[39]V. Pughazhendi, "Project report on constraint research : An approach to study the technical, economic and social barriers of productivity increase in potato in Nilgiris district of Tamil Nadu (Coimbatore : Tamil Nadu Agricultural University, 1980), p.16.

[40]P.R. Ranganathan, "An economic analysis of yield gap in rice production in Madurai east block, Madurai district", (Unpublished M.Sc(Ag.) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1984), p.22

[41]G. Parthasarathy, "Constraints for rapid increase in rice yields in north coastal Andhra", (Agro-economic research centre, Andhra University, Research Report No.50 1986), pp.120-121.

[42]J. Vasanthakumar and P. Selvaraj, "Yield gap in composite fish culture-an analysis", Kurukshetra, **36**(4): 18-20, 1986.

the yield obtained at the research level under controlled conditions;

ii) farm level yield gap-the difference in the research level yield and the yield obtained in National demonstrations and the fields of the best farmers; and

iii) economic yield gap-the difference between the long run economic yield potential which corresponds to minimum average cost (including normal profit) and the actual yield obtained at farm level[43].

Meenakshisundaram and Sunderesan opined that gap I was total gap that might be bridged with the present level of technology while gap II is the difference between what was possible yield and maximum yield recorded by sample farms[44].

Gangwar and Pandey defined yield gap as the difference between average yield of farm and yield obtained by progressive farmers or in the trials conducted on the farmers fields[45]. But Widawsky and Toole stated gap I, as the difference between experimental station maximum yield and on farm experimental maximum yield and gap II as

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[43]V.K. Pandey and S.K. Tewari, "An analysis of cost functions and economic yield gaps in sugarcane production in western U.P. for some policy implications", Indian Journal of Agricultural Economics, **23**(3), 481, 1988.

[44]V. Meenakshisundaram and R. Sundaresan, "Problems and Prospects of horsegram production in Tamil Nadu", Agricultural Situation in India, **43**(10), p.115, 1988.

[45]A.V.Gangwar and R.N. Pandey, "Bridgeable yield gaps : constraints and prospects of attaining additional farm income in the context of crop production technology", (Hissar : Haryana Agricultural University, Report No.20, 1989), p.27.

the difference between actual farmers' yield and yield obtained in on-farm experiments[46].

Singh defined yield gap as the gap existing between the potential yield already attained by some progressive farmers and the average local yield within the similar agro-climatic and resource endowment situation such as a block or tehsil[47].

Singh and Yadav have categorised yield gap into the research-cum-management gap (the difference in yield of research station and farmers potential yield) and extension gap (the difference between potential and actually realised yields on farmers field)[48].

Mani and Pandey conceptualised yield gap at three different levels. First, the difference between the genetic potential yield and the research level yield obtained in controlled experiments ie., 'theoretical yield gap'. Second, the difference between the yield obtained at research level and yield of the progressive farmers adopting recommended technology ie., 'field level yield gap'. Third, the difference between yield of the progressive farmers and yield of non-progressive average farmers of an area ie., 'farm level yield gap'[49].

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[46]A.David Widawsky and John.C.O. Toole, "Prioritizing the rice biotechnology research agenda for eastern India (Washington : The Rockfeller foundation, 1989), p.10.

[47]L.R.Singh, "Summaries of a group discussion, Subject III-Commercial crops", Indian Journal of Agricultural Economics, **44**(1): 15-20, 1989.

[48]K.Singh and J.P. Yadav, "Gaps and constraints in wheat productivity : A systems analysis", Agricultural Situation in India, **44**(8): 627-631, 1989.

[49]Gyanendra Mani & V.K. Pandey, "Cropping pattern and yield gaps under dry land farming conditions in U.P.", Agricultural Situation in India, **45**(12): 1007-1010, 1990.

Thiruvenkatachari, Viswanathan and Seetharaman defined yield gap as the difference in the yield between the one obtained by the demonstration plots using recommended dosage of inputs and the yield registered by the individual sample farmers[50].

Ramasamy, Shanmugham and Suresh Kumar decomposed yield gap into two parts viz., Yield gap I which is the difference between an experiment stations's maximum yield and an on-farm experiments' maximum yield and yield gap II which is the difference between actual farm yield and yield attained in on-farm experiments[51].

In the present study yield gap is divided into two components viz., gap I and II. Yield gap I is the difference between the physical maximum possible yield obtained in the experimental station and maximum yield obtained from among the sample farms. Yield gap II is the difference between the maximum farm level yield and the average yield obtained in the farmers' field.

REVIEW OF PAST STUDIES

Growth Rate

Sain estimated the rate of growth of area under the principal high yielding varieties of crops, their production and

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[50]K.Thiruvenkatachari, B.N. Viswanathan and K.S. Seetharaman, "An Economic analysis of groundnut production in rainfed area-A study in Tamil Nadu", Agricultural Situation in India, **46**(6): 433, 1991.

[51]C.Ramasamy, T.R. Shanmugham & D. Suresh Kumar, "Constraints to higher rice yields in different rice production environments and prioritization of rice research in Southern India" (Coimbatore : Tamil Nadu Agricultural University, 1994), p.3.

productivity in India. He used both linear and compound growth rates[52].

Rudra tried out three different curves for the purpose of trend fitting to a statistical series-viz., the straight line, the semi-logrithmic curve and the Gompertz[53].

Dey studied the rate of growth of agriculture and industry, using two types of growth curves viz., the exponential and Gompertz. While the exponential function used for the study was of the following form,

$Y_t^* = ab^t$ where, Y_t^* are trend values and a and b are parameters

The equation for Gompertz was $Y_t^* = K\ a^{b^t}$ which in the logarithmic form is $\log Y_t^* = \log K + (\log a) b^t$ where K_t is the asymptote and a and b are parameters[54].

Reddy examined statistically whether there was an indication of acceleration or retardation in the Indian national income using simple growth curves like linear, log-linear and Gompertz[55].

Compound growth rate of area, production and productivity was estimated during pre-high yielding variety period (1955-56 to 1964-65) and high yielding variety period (1965-66 to 1977-78) by

[52] K.Sain, "Impact of high yielding varieties on agricultural growth", Commerce, **139**(3577) : 53, 1979.

[53] Rudra Ashok "Economic Development in South Asia" (Kandy conference proceedings, London : The Macmillan Company, 1970), pp.340-365.

[54] A.K. Dey, "Rates of Growth of Agriculture and Industry", Economic and Political Weekly, **10**(25,26): A-26 to A-30, 1975.

[55] V.N.Reddy, "Growth Rates", Economic and Political Weekly, **13**(19): 806-812, 1978.

Rao, Mahajan and Sarma by using the least square technique of fitting the exponential equation[56].

$Y = ab^t$, in the log linear form, $\log Y = \log a + t \log b$ where

Y = variable for which growth rate is calculated

a = constant

t = time variable measured in years

b = 1 + r, while r = compound growth rate

Krishnaji studied the conceptual problems in measuring agricultural growth by using a set of pre-specified forms of trend. The set consisted of

$Y_t = a + b_t + E_t$ .... (1)

$Y_t = a + b \log t + E_t$ .... (2)

$\log Y_t = a + b_t + E_t$ .... (3)

$\log Y_t = a + b \log t + E_t$ .... (4)

wherein, in each case, E_t were independently and identically distributed normal variables with zero mean and constant specified variance. Among the forms, the author found (1) and (3) ie., linear and exponential trend as the best fit[57].

Yoginder K Alagh and Sharma used linear and log linear functions to examine whether the growth of crop production was decelerating from 1960-61 to 1978-79 or otherwise[58].

[56] A.V.Rao, R.K. Mahajan and Y.R.B. Sarma, "Growth analysis of statewise area, productivity and production of rice in India", Agricultural Situation in India, **36**(3): 171-175, 1981.

[57] N. Krishnaji, "Measuring Agricultural Growth", Indian Journal of Agricultural Economics", **35**(2): 31-41, 1980.

[58] Yoginder, K. Alagh and P.S. Sharma, "Growth of crop production 1960-61 to 1978-79- is it decelerating?", Indian Journal of Agricultural Economics", **35**(2): 104-118, 1980.

Misra arrived at the compound growth rate of yield and area of rice by using the exponential equation[59].

Leonardo and Sarma analysed the trend in production, area harvested and output per hectare of food crops in Brazil using a semi-log trend equation[60].

In a study on variability and trend in area, production and productivity of rice in Konkan region of Maharashtra, Sanense, Borude and Patil used compound growth rates[61].

Kalita and Baruah studied growth of rice in Assam using time series data on area, production and productivity for different types of rice from 1951-52 to 1988-89. A simple linear regression exercise was performed using the data where output was regressed against a time trend variable[62].

Jamal and Zaman attempted to decompose the growth trend in agricultural output without any residual terms by using a multiplicative approach[63].

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[59]Baidynath Misra, "Deceleration of rates of agricultural growth in Orissa : Trends and explanatory factors", Indian Journal of Agricultural Economics, **38**(4): 591-604, 1983.

[60]Leonardo A. Paulino and J.S. Sarma, "Analysis of trends and projections of food production and consumption in Brazil and Nigeria", (Washington : International Food Policy Research Institute, 1988), p.12.

[61]S.L.Sanense, S.G. Borude and H.N. Patil, "A study on variability and trends in area, production and productivity of rice in Konkan region of Maharashtra", Journal of Maharashtra Agricultural Universities, **15**(1): 86-89, 1990.

[62]D.R.Kalita and B.K. Baruah, "Growth of rice in Assam", Agricultural Situation in India, **47**(4): 263-266, 1992.

[63]H.Jamal and A. Zaman, "Decomposition of Growth Trend in Agriculture : another approach", Indian Journal of Agricultural Economics, **47**(4): 644-652, 1992.

Haffis **et al** also examined the emerging trend in area, production and productivity of foodgrains in India. For calculating compound growth rate, the exponential function was fitted[64].

Kuchchadiya **et al** analysed the growth and technological development in oilseeds in Gujarat using compound growth rate function[65].

Rao and Tewari studied growth performances of niger crop in major cultivating states by fitting three trend functions, viz., linear, semi-log and double-log[66].

Bhowmick and Ahmed used linear and compound growth rates to study growth rate of area, production and productivity of major oilseed crops in Assam[67].

To estimate the growth rates of pepper trade indicators, an exponential model of type $Y_t = a\, e^{bt}$ ($\log Y_t = \log a + bt$) has been fitted using OLS technique by Jeromi and Ramanathan[68].

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[64]Shaik Haffis., Y.V.R. Reddy, P. Lakshmi and R.K. Raju, "Growth pattern in foodgrains economy of India", Agricultural Situation in India, **46**(12): 905-909, 1992.

[65]D.B.Kuchchadiya, R.L. Shiyani, S.K. Dixit and H.R. Pandya, "An analysis of growth and technological development in oilseeds in Gujarat", Agricultural Situation in India, **45**(3): 175-179, 1991.

[66]V.M.Rao and Devi.D. Tewari, "Growth performance of niger crop- a statewise analysis", Agricultural Situation in India, **46**(12): 38-49, 1992.

[67]B.C.Bhowmick and A.V. Ahmed, "Behaviour of trend and growth of area, production, productivity and supply response of major oilseed crops in Assam", Agricultural Situation in India, **48**(1): 3-9, 1993.

[68]P.D.Jeromi and A. Ramanathan, "World pepper market and India- an analysis of growth and instability", Indian Journal of Agricultural Economics, **48**(1): 88-97, 1993.

Kaushik worked out compound growth rates of area, production and productivity of oilseeds in India using the function log $Y_t = a + bt$[69].

Sinha and Thakur found the growth rates of area, production and productivity of rice, wheat and maize using the exponential function[70].

Yield gap

Davidson and Martin undertook a systematic study of the relationship between yields on farm and at experimental stations in Australia for a number of crops. They found that the gap between farm yields and experimental stations' yields varied with growing seasons. In good years, the yield at the experiment stations increased more rapidly than that of the farms in the same district. They concluded that this was mainly because farmers were constrained in their input investment by their desire to maximise profit, while the experiments with little or no cost restraint, attempted to maximise yield (physical output)[71].

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[69]Krishan Kànta Kaushik, "Growth and instability of oilseeds production", Indian Journal of Agricultural Economics, **48**(3): 334-338, 1993.

[70]D.K.Sinha and Jawahar Thakur, "An economic analysis of growth performance of major food crops in Bihar", Agricultural Situation in India, **48**(7): 543-549, 1993.

[71]B.R. Davidson and B.R. Martin, "The relationship between yields in farms and in experiments", Australian Journal of Agricultural Economics, **9**(2): 129-140, 1965.

Although Herdt and Wickham defined yield gap, they did not specify which it referred to, but it appears that they referred to total gap.

Ashan, the International Rice Agro-economics network group (IRAEN) of agronomists, statisticians and agricultural economists, conducted a set of management mini kit experiments in Andhra Pradesh. It was hypothesised that the yield gap was caused by variability in cultural practices such as land preparation, depth of transplanting seedlings and weeding. They opined that by simulating farmer's practices (sub-optimal) yields could be increased considerably[72].

For estimating the factors responsible for yield gap, Pughazhendi fitted a linear yield gap function taking into consideration of dummy variables for high yielding variety, value of seeds, fertilizers and pesticides, credit borrowed and attitude towards new technology as independent variables and yield gap per acre as dependent variable. He concluded that high yielding varieties and attitude towards new technology were negatively and significantly related to yield gap[73].

Radhakrishnan used linear yield gap function for estimating the factors responsible for yield gap in dryland cotton in Kovilpatti and concluded that quantity of fertilizer applied,

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[72] A.A.M. Ekramul Ashan, "Concepts on exploring the gap between potential and actual rice yields- The Philippines case", <u>Constraints to high rice yields on Asian rice farms : An Interim Report</u>, (Manila : International Rice Research Institute, 1977), pp.25-38.

[73] V. Pughazhendi, <u>op.cit</u>, p.36.

human labour used in mandays and awareness and adoption of new technology have significantly affected yield gap[74].

Ranganathan fitted a linear yield gap function for identifying the factors influencing yield gap in paddy in Madurai district. He concluded that inadequate use of certified seeds, age of the transplanted seedlings, fertilizer use, technical knowledge of farmers and labour were significantly affecting the yield gap of paddy[75].

Udayakumar studied the yield gap in coarse cereals in Coimbatore district using linear yield gap function for cholam, cumbu, ragi and maize with human labour in mandays, organic manure in quintals per hectare, fertilizer and plant protection cost and a dummy variable for variety as independent variables and yield gap (%) as the dependent variable. He identified lack of credit, input supply and knowledge about improved practices to be the major constraints in coarse cereal cultivation[76].

Basavalga analysed the yield gap and constraints in cotton production in Karnataka. Multiple regression analysis revealed plant nutrients, labour cost, soil type, sowing time, method of fertilizer application, access to credit and participation in

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[74] S.Radhakrishnan, "Constriants to potential productivity of rainfed cotton in Kovilpatti block, Tirunelveli district (Unpublished M.Sc(Ag) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1981), p.104.

[75] P.R.Ranganathan, op. cit. p.107.

[76] V.Udayakumar, "Coarse cereals in Coimbatore district-growth pattern, crop decisions, yield gap and the economics", (Unpublished M.Sc(Ag) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, 1984), p.32.

extension education programmes to be significantly contributing to the yield gap[77].

Singh and Yadav quantified extension gap in wheat. Multiple regression was used to identify the relative contribution of technological gap index, soil fertility management, credit, prices of product, socio-economic status and extension agency contact on extension gap. Technological gap, credit, soil fertility management and socio-economic status were found to influence the extension gap significantly[78].

Sharma, Oberoi and Moorti assessed the technological gap and production potential of potato farming in Kangra district of Himachal Pradesh. According to them the working capital would raise the output substantially and the fertilizer shortages were viewed as major determinants of the technological gap[79].

Shanmugham and Thirupathi used Cobb-Doglas type production function for identifying the influence of technical and socio-economic constraints on yield gap in hybrid cotton seed enterprise. The availability of agricultural chemicals and nutrients in proper time and labour supply during peak seasons were found to be the important technical constraints. Lack of education and poor access to credit were the socio-economic factors influencing yield gap[80].

[77]H.Basavalga, H. op. cit. p.51.

[78]K.Singh and J.P. Yadav, op. cit. pp.627-631.

[79]A.K.Sharma, R.C. Oberoi and T.V. Moorti, "Technological gap and production potential in potato farming of mid-hills of Himachal Pradesh", Journal of Indian Potato Association, 18(1&2): 48-55, 1991.

[80]T.R. Shanmugam and V. Thirupathi, "Productivity gap in a hybrid cotton seed enterprise", Productivity, 34(3): 90, 1993.

Constraint Analysis

Shakya and Flinn studied the technical and economic factors influencing the adoption of modern varieties and the use of fertilizers on rice. They found that irrigation, tenure status and access to credit influenced varietal adoption and fertilizer price influenced their adoption and use rates on rice[81].

Factors accounting for low yields of rice were enumerated by Haque, as high price of inputs, lack of suitable plant protection measures, topography, water logging, lack of adequate irrigation, lack of adequate capital, moneylenders exploitation, absence of appropriate water management and non-availability of quality inputs on time[82].

Patnaik studied the production constraints in rainfed rice. He identified poor crop stand, severe weed infestation, loss of applied nutrients and pest and disease incidence to be the major bottlenecks in rice production[83].

Pughazhendi studied the constraints in productivity increase in potato in the Nilgiris district and concluded that high yielding

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[81]B.Padma Shakya and J.C. Flinn, "Adoption of modern varieties and fertilizer use on rice in Eastern terai of Nepal", Journal of Agricultural Economics, **36**(3): 409, 1985.

[82]T.Haque, "Factors accounting for low yields of rice in West Bengal", Agricultural Situation in India, **40**(9): 775-783, 1985.

[83]S.Patnaik, "New production technology for rainfed rice", Agricultural Situation in India, **43**(6): 521, 1988.

varieties and attitude towards new technology were negatively and significantly related to yield gap[84].

Singh, Thomas and Chandra stated that the constraints to dryland rice production in India were inadequate irrigation facilities, low adoption level of high yielding varieties, fertilizers, plant protection measures, non-availability of good quality seeds and ferilizers in time and poor topography[85].

Satyanarayana stated that non-location specific long duration, photosensitive varieties, susceptible to pests and diseases, weed infestation and moisture stress at terminal phase were the major problems in rice fallow pulse production in Tamil Nadu and Andhra Pradesh[86].

Singh, Srivastava and Rizhi studied the constraints in the adoption of technology in pulses at farm level in Bihar. They identified lack of adequate and timely supply of improved seeds, occassional drought situation and pest and disease attack as the main constraints[87].

Umesh and Bislaiah studied the yield gap and constraints in groundnut cultivation in Karnataka. They found that the non-

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[84] V.Pughazhendi, op. cit, p.36.

[85] R.P. Singh, Saji Thomas and Naresh Chandra, "Factor demand, output supply and constraints to dryland rice production in Ranchi district of Bihar", Agricultural Situation in India, **44**(4): 268, 1989.

[86] A.Satyanarayana, "Pulses in rice fallows", Agricultural Situation in India, **43**(6): 57, 1988.

[87] U.P.Singh, G.C. Srivastava, S.H. Rizhi, "Pulses production technology, adoption and constraints in Bihar", Agricultural Situation in India, **43**(6): 641-646, 1989.

availability of inputs and their cost, lack of credit, marketing and technical guidance were the major constraints[88].

Narang studied the demand and supply gap in edible oils in India and found that the cultivation of oilseeds in rainfed marginal lands, the non-use of needed quantity of inputs, aberrations in monsoon, procurement, marketing and storage problems acted as disincentives for the growers and the factors for low yield of oilseed crops in India[89].

Trivedi studied the problems in augmenting the productivity of rainfed agriculture and found lack of appropriate tillage and moisture conservation measures, lack of credit, non-application of manures, fertilizers, plant protection and weed management measures to be the major impediments[90].

Reddy reported fear of risk due to monsoon failure, lack of conviction of improved technology and lack of finance to invest on improved technology to be the main reasons for non or partial adoption of technology[91].

Sharma and Moorti studied the resource use efficiency in tea cultivation and observed that labour scarcity, lack of skilled

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[88]K.B.Umesh and S. Bislaiah, "Constraints to oilseeds production : A case study of groundnut in Karnataka", Agricultural Situation in India, **44**(7): 553-557, 1989.

[89]M.S.Narang, "Performance and prospects of major oilseed crops in India", Agricultural Situation in India, **44**(7): 563, 1989.

[90]G.Trivedi, "Making drylands of Bihar bloom", Agricultural Situation in India, **43**(5): 40, 1988.

[91]Y.V.R.Reddy, "Economics and adoption level of improved dryland technology among the targeted and non-targeted farmers in A.P., Agricultural Situation in India, **43**(8): 10, 1988.

labour, field extenstion services and untimely payments to tea growers by the co-operative factories as the major constraints in tea farming[92].

Singh and Yadav studied the constraints in wheat productivity and found that management-cum-environmental factors/physical parameters were the major constraints for research cum management gap[93].

Balisther and Singh found non-availability of canal water in time, high yield uncertainity due to pest and diseases, non-availability of stable new high yielding varieties and absence of improved technology for pulses as the major constraints to pulses production in Uttar Pradesh[94].

Ajore and Singh observed that low yields of rice and wheat in Uttar Pradesh were obtained due to partial or non-adoption of land reclamation techniques of sodic soils[95].

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[92]Raunder Sharma and T.V. Moorti, "Economics of Resource Use : A study of Himachal Pradesh tea farmers", Agricultural Situation in India, **44**(2): 120, 1989.

[93]K.Singh and J.P. Yadav, op. cit, p.630.

[94]Balisther and Roshan Singh, "Oilseeds and pulses production in Agra district, U.P." Productivity, **34**(4): 700-703, 1994.

[95]Ram Ajore and A.P. Singh, "Causes for wide gaps in rice and wheat on sodic soils in progressive and less progressive districts in U.P." Agricultural Situation in India, **49**(1): 101-103, 1994.

In the present study, biological, technical and socio-economic constraints causing yield gap were considered. The biological and technical constraints included lack of suitable varieties, water problem, drainage problem and pest and diseases. In the socio-economic constraints, lack of owned funds, lack of credit facilities, poor quality of inputs, lack of knowledge, lack of extension contact, unfavourable market and lack of storage and marketing facilities were given due consideration in the study.

DESIGN OF THE STUDY

CHAPTER-III

DESIGN OF THE STUDY

The purpose of the study is to isolate the factors responsible for fluctuations in area under potato in the Nilgiris district besides identifying the yield gap and its associated determinants. Appropriate methodology is necessary to draw meaningful inferences of any study. The methodology adopted for the selection of sample units, collection of data and tools of analysis used in the study are discussed in what follows.

CHOICE OF THE UNIVERSE:

The present study was carried out in the Nilgiris district since it had more area under potato among the three potato growing districts of Tamil Nadu. Besides it had also exhibited declining trend in potato area. Among the four taluks of the Nilgiris district, Udhagamandalam taluk was selected purposively as the universe for the study on account of its large area under potato as compared to the other three taluks. Further the decline in area under potato is more pronounced in this taluk as compared to other taluks. Besides there existed wide variation in the yield among the potato growers, progresssive farmers and experimental station. The location of the study area within the reach of the researcher was yet another reason for the selection of the taluk.

JUSTIFICATION FOR SELECTION OF POTATO CROP

Potato is grown in Tamil Nadu in an area of 4911 ha during 1991-92. It is concentrated in the three districts viz., the

Nilgiris, Dindugal-Anna, and Dharmapuri of the State. Of the afore said districts, the area under potato has been declining in the Nilgiris district steadily over years as could be seen in Table-I

TABLE I

AREA UNDER POTATO IN THE NILGIRIS DISTRICT

(in hectares)

S.No.	YEAR	AREA	% change over 1981-82
1.	1981-82	7736.32	-
2.	1982-83	6900.41	-10.81
3.	1983-84	6938.50	-10.31
4.	1984-85	7041.68	-8.98
5.	1985-86	5594.92	-27.68
6.	1986-87	5609.37	-27.49
7.	1987-88	5881.79	-23.97
8.	1988-89	4555.14	-41.12
9.	1989-90	6441.59	-16.74
10.	1990-91	3331.33	-56.94
11.	1991-92	2659.00	-66.63
12.	1992-93	2866.61	-62.95
13.	1993-94	3301.00	-57.33
	Average	5296.73	-31.53

Source : Records of the Assistant Director of Statistics, Udhagamandalam.

From the table it is evident that the area under potato had declined from 7736.32 hectares in 1981-82 to 3301.00 hectares in 1993-94. On an average there had been a decline in the area under potato to the extent of -31.53 per cent over a span of thirteen years. So, potato crop was purposively chosen for the study for identifying the causative factors responsible for such a drastic decline.

SELECTION OF THE SAMPLE

The Nilgiris district consists of four taluks viz., Udhagamandalam, Coonoor, Kotagiri and Gudalur. Among these four taluks,the area under potato is highest in Udhagamandalam taluk. The area under potato in the four taluks of the Nilgiris district is shown in Table II.

TABLE II

TALUKWISE AREA UNDER POTATO IN THE NILGIRIS DISTRICT

(in hectares)

S.No.	YEAR	UDHAGAMANDALAM	COONOOR	GUDALUR	KOTAGIRI
1.	1981-82	5011.2 (64.77)	1991.0 (25.74)	-	734.12 (9.49)
2.	1982-83	4470.8 (64.79)	1740.6 (25.22)	-	688.92 (9.98)
3.	1983-84	4412.0 (63.58)	1796.4 (25.89)	-	730.05 (10.52)
4.	1984-85	4509.9 (64.05)	1864.6 (26.48)	-	667.08 (9.47)
5.	1985-86	4000.0 (71.49)	869.5 (15.54)	-	725.37 (12.96)
6.	1986-87	4337.0 (77.32)	770.9 (13.74)	-	501.41 (8.94)
7.	1987-88	4503.0 (76.55)	848.08 (14.41)	-	530.7 (9.02)
8.	1988-89	3327.0 (73.04)	836.00 (18.35)	36.32 (0.80)	355.51 (7.80)
9.	1989-90	5141.38 (79.82)	1000.42 (15.53)	-	299.78 (4.65)
10.	1990-91	2633.52 (79.05)	574.65 (17.24)	-	123.15 (3.69)
11.	1991-92	2013.0 (75.71)	557.00 (20.94)	-	89.00 (3.35)
12.	1992-93	2320.6 (80.95)	416.69 (14.54)	-	129.27 (4.51)
13.	1993-94	2845.0 (86.19)	378.00 (11.45)	-	78.00 (2.36)
	Average	3809.57 (71.92)	1049.53 (19.81)	2.82 (0.05)	434.79 (8.21)

Figures in parantheses indicate percentage area to total area under potato in the district.

Source : Records of the Assistant Director of Statistics, Udhagamandalam.

From the table,it could be seen that in 1993-94,the area under potato in Udhagamandalam taluk accounted for 86 per cent of the area under potato in the Nilgiris district and on an average it constituted about 71.92 per cent of the total area under potato in the Nilgiris district. Therefore, Udhagamandalam taluk was purposively chosen for the study.

SAMPLING PROCEDURE

Udhagamandalam taluk consists of twenty villages. Of these twenty villages, six villages having the largest area under potato and at the same time exhibiting declining trend has been selected.The list of villages selected is given in Table-III. The location of the sample villages is given in Figure 1.

TABLE III

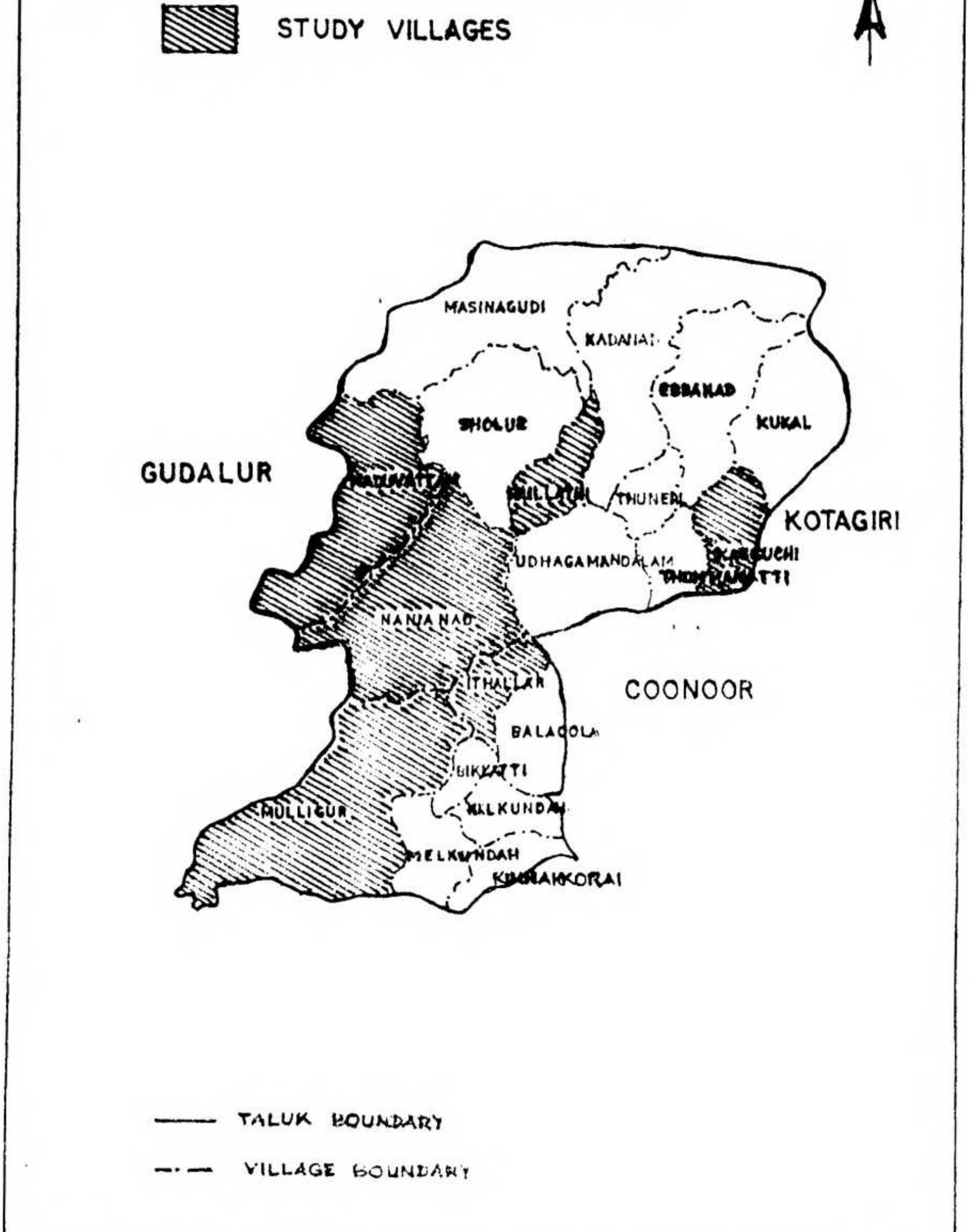
AREA UNDER POTATO IN THE SELECTED VILLAGES

(in hectares)

S.No.	NAME OF VILLAGE	1991-'92	1992-'93
1.	Nanjanad	277.0	227.0
2.	Mulligoor	142.0	57.0
3.	Ithalar	119.0	32.0
4.	Naduvattam	150.0	59.0
5.	Hullathi	252.0	165.0
6.	Kagguchi	250.0	87.0

Source : Records of the Assistant Director of Statistics, Udhagamandalam.

FIG.1. MAP OF UDHAGAMANDALAM TALUK



In each vllage, fifteen potato growers were selected at random. In all, ninety potato growers were contacted for the present study.Similarly, five progressive farmers were selected at random from each of the six villages constituting a sample of thirty progressive farmers. In all, one hundred and twenty farmers were contacted for the study. Based on discussion with the developmental authorities, the potato growers were stratified into potato growers and progressive potato growers. Those farmers who are aware of the recommended package of practices of potato cultivation and have adopted the same to a larger extent have been reckoned as progressive potato growers. Since there existed no wide disparity in size groups, the classification of progressive potato growers was not resorted to. Those farmers who are aware of the recommended level of technology but are not adopting it, in comparison to their counterparts, have been classified as ordinary potato growers in the present study.

In order to study the yield gap and difference in technology adoption among the farmers and research station, data on field experiments conducted at the university research station at Vijayanagaram were also collected.

COLLECTION OF DATA

A well structured interview schedule bearing questions in relation to the specific objectives of the study was used for data collection.A reconnaissance survey was conducted to gain first hand information on the agro-climatic and socio-ecomnomic conditions of the study area and also to find the scope for investigating the yield gap in that area. The schedule was pre-tested to eliminate irrelevant and ambiguous questions and to make necessary modifications. The pre-tested schedule was thus finalised and used for the collection of required data.

Required primary data were collected by personal contact with the randomly selected sample farmers using the interview schedule. The information collected included asset position ie. extent of land holding, buildings and deadstock particulars, livestock particulars, irrigation sources, cropping pattern, periodicity of cropping pattern, area and yield of potato in the last five years, choice of variety and reasons for choice of variety and the technical and socio-economic constraints faced in potato cultivation. The quantities of factors and products were stated by the respondents in local units.They were converted into standard units. The cross-verification of data was done then and there to ascertain the reliability, adequacy and consistency of the data collected.

Particulars pertaining to agro-climatic features, irrigation facilities, soil type, land use pattern, cropping pattern, infra structural facilities and developmental schemes in operation in the Nilgiris district were collected from the records of the Assistant Director of Statistics, Udhagamandalam. The potential yield data was collected from the university research station, Udhagamandalam.

Study period : The reference year for the study was 1993-'94. Collection of data from the sample respondents was taken up during the months of October-November, 1994.

METHOD OF ANALYSIS

The sample farmers were post-stratified based on area of the individual holdings into two groups viz., small farmers and large farmers, since there existed wide disparity among them with regard to the inputs usage and yield obtained by them. However, the progressive farmers were considered as a single entity for all analysis.

TOOLS OF ANALYSIS

Simple percentages and averages were worked out to interpret the data related to the agro-climatic conditions, land utilisation pattern, distribution of land holdings, irrigation and cropping pattern and also to bring out the characteristics of the sample farms. Besides, the following tools of analysis were employed in order to present the facts in a cogent manner and to draw meaningful inferences.

1. Growth rate

The Gompertz growth model was used to estimate the rates of growth of area, production and productivity of potato in the Nilgiris district over different time periods. The growth curves are generally characterized by slow initial growth, a period of rapid expansion and a subsequent levelling off when maximum capacity is reached. Much stress is given to the Gompertz growth model in this study as it has two distinguishing characteristics.

i) The relative rate of growth declines at a constant rate.

ii) The curve does not posses a turning point, asymptotically approaching an upper limit.

The Gompertz growth model is of the form $Y = A \exp(-\exp(\alpha - \beta t))$ where α and β are constants. A reasonable initial estimate, A may be obtained visually as the approximate maximum value approached by the response Y (dependent variable) as X approaches infinity. Though the model is a non-linear model with multiplicative error assumption, if the use of Gauss-Newton algorithm for the estimation of the parameters of the model may not converge, in such cases, the estimates of the parameters can be done by means of principle of least squares which is more closely associated with the respective estimates by non-linear algorithms[1].

The relative growth rate (RGR) = $(\beta \exp(\alpha - \beta t)) \times 100$

The curve was fitted to the time series data of area, production and productivity of potato in the Nilgiris district and the growth was computed.

2. Yield gap analysis

Instead of comparing the actual farm yield directly to the experimental station yield, an intermediate yield level between the two was introduced, called maximum farm yield, which indicated the yield obtainable in the farmers' field from improved techonology.

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[1]David A. Ratkowsky, "Non-linear regression modeling-a unified practical approach" (U.S.A.; Library of Congress Cataloguing in publication data, 1983) p.69.

The yield gap was thus divided into yield gap I which corresponds to the difference between experiment station yield and maximum farm yield and yield gap II which corresponds to the difference between the maximum farm yield and farmers' average yield.

Yield gap I might be due to environmental difference between the experiment station and farmers' field or by non-transferable technology; some aspects of high yielding technology developed at experiment stations did not produce high yield under actual conditions or both.

Yield gap II might be due to technical and socio-economic constraints. Technical constraints include lack of suitable varieties, water scarcity during first season, pests and diseases and weeds. Socio-economic constraints includes credit, input availability, knowledge, marketing infra-structure and price.

Yield gap function :

Yield is a cumulative result of a series of factors acting and reacting on each other having a reinforced effect. Therefore multiple regression model was the only feasible tool to study the influence of each of the variables on yield gap II.

Yield gap II was regressed on the deviations in the quantity of inputs-seeds, farm yard manure, potato mixture and plant protection chemicals from their recommended levels, the actual number of irrigations carried out (since the soil type is a variant) and the educational level of the respondents, all of which the researcher felt would greatly influence the yield gap. After examining the scatter diagram of the dependent variable, yield gap II and the above listed independent variables, the functional form for the crop under review was specified as linear production function.

The yield gap function was specified as follows:

Linear function:

$$Y = b_o + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + b_6 x_6 + e$$

where,

Y = Yield gap in kg/ha

x_1, x_3, x_4, x_5 represent the deviation of actual level of input used from the recommended level.

x_1 = Quantity of seed used (kg/ha)

x_2 = Number of irrigations

x_3 = Quantity of FYM applied (kg/ha)

x_4 = Quantity of potato mixture applied (kg/ha)

x_5 = Quantity of plant protection chemicals (kg/ha)

x_6 = Education of respondent measured in actual years of schooling

b_o-b_6 = Parameters to be estimated

e = stochastic error term

3. Garrett's ranking technique :

This method was suggested by Garrett for converting the ranks into scores when number of items ranked differed from respondent to respondent. A set of biological and socio-economic constraints which prevent the farmers from adopting the recommended levels of fertilizers, plant protection chemicals and seeds were administered and the respondents were asked to rank them in the order of importance. The per cent position of each rank was found using the formula,

$$\text{Per cent position} = \frac{100\,(R_{ij} - 0.5)}{N_j}$$

where,

R_{ij} = Rank given to i^{th} item by j^{th} individual

N_j = Number of items ranked by j^{th} individual

The per cent position of each rank thus obtained was converted into scores by referring to the Garrett's table. For each problem, the scores of individual respondents were added together and divided by the total number of respondents for whom the scores existed, to arrive at the mean score for all the problems. Based on the mean score, the items were arranged in a descending order and ranks were given[2].

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[2]Henry Garrett, E., "Statistics in Psychology and Education", (Bombay : Vakils, Jeffer and Simons Private Limited, 1969), pp.328-331.

DESCRIPTION OF THE STUDY AREA

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

A thorough understanding of agro-climatic conditions of the study region relating to topography, soil type, rainfall distribution, temperature, cropping pattern and infra-structural facilities is essential for any study pertaining to agricultural development. A closer look at the general socio-economic and agro-economic conditions of the study area is a pre-requisite to draw meaningful inferences from the results of the study. This chapter brings to light these features of the area studied.

LOCATION

The Nilgiris district comprising an area of 2,543 square kilometres lies in the North-West corner of Tamil Nadu between 11.8^{o} and 11.55^{o} of the northern longitude and 76.13^{o} and 77.2^{o} of the eastern latitude. For the purpose of administration, the district has been divided into four taluks viz., Udhagamandalam, Coonoor, Kotagiri and Gudalur with the district headquarters at Udhagamandalam.

Udhagamandalam taluk, comprising an area of 1,202.33 square kilometres is located in the heart of the Nilgiris district at an altitude of about 2,310 metres above mean sea level.It is bounded by Kotagiri and Coonoor taluks in the east, Gudalur taluk in the west, Karnataka state in the north and the Malabar region of Kerala state in the south.

CLIMATE AND RAINFALL

Because of its location at a high altitude, Udhagamandalam taluk has a temperate and equable climate. The mean normal rainfall of this district is 1,125.00 mm of which about 50 per cent is received in the South-West monsoon period, 30 per cent during the North-East monsoon and 20 percent during the summer periods. The monthwise distribution of rainfall for the period 1982-1993 is furnished in Table-IV.

From the table, it could be seen that the mean monthly rainfall was highest during the South-West monsoon period ie., during the months of July-September. The North-East monsoon also contributes high rainfall during the months of October-December. However, high instability was observed in the months of January, February and March. The temperature exhibits wide fluctuations ranging from 0°C to 25°C. April, May and June represent the hottest period when maximum temperature reaches 25°C, while the coldest months are November, December and January when the minimum temperature reaches even 0°C. During these cold months, frost occurs frequently which adversely affects the growth and yield of vegetable crops including potato.

TOPOGRAPHY AND SOIL TYPE

Since Udhagamandalam taluk is situated in the Nilgiris mountains, the topography is rugged and undulating and cultivation is possible where the slope does not exceed 30 per cent. Flat lands and swamps intervening the rugged terrain are utilised for growing vegetables. Tea is suited for slopy and dry lands. The

TABLE IV

MONTHWISE DISTRIBUTION OF RAINFALL IN THE NILGIRIS DISTRICT 1982-93

(in mm)

Year	Jan.	Feb.	Mar.	Apl.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1982	-	-	4.0	66.0	125.0	151.0	127.0	98.0	141.0	119.0	142.0	20.0	993.0
1983	1.0	-	3.0	16.0	142.0	195.0	155.0	129.0	100.0	86.0	56.0	101.0	984.0
1984	16.0	37.0	113.0	27.0	44.0	204.0	281.0	44.0	115.0	233.0	25.0	179.0	1318.0
1985	10.0	-	15.0	94.0	32.0	182.0	34.0	35.0	153.0	57.0	73.0	100.0	785.0
1986	36.0	58.0	15.0	9.0	99.0	177.0	86.0	172.0	204.0	75.0	83.0	60.0	1074.0
1987	12.0	-	16.0	33.0	99.0	97.0	80.0	123.0	161.0	229.0	113.0	108.0	1071.0
1988	-	-	96.0	143.0	98.0	93.0	293.0	188.0	212.0	79.0	29.0	16.0	1247.0
1989	-	-	11.0	43.0	82.0	98.0	486.0	68.0	205.0	193.0	49.0	5.0	1240.0
1990	47.0	-	4.0	57.0	217.0	66.0	89.0	129.0	73.0	227.0	85.0	40.0	1034.0
1991	8.0	-	5.0	111.0	85.0	153.0	300.0	142.0	123.0	243.0	72.0	3.0	1245.0
1992	5.0	-	-	57.0	157.0	387.0	130.0	119.0	127.0	113.0	281.0	2.0	1378.0
1993	-	2.0	19.0	26.9	91.6	162.9	109.8	77.7	149.0	211.8	199.9	98.9	1149.5
MEAN	11.25	8.08	25.08	56.91	105.97	163.83	180.9	110.39	146.92	155.48	100.66	61.08	1126.54
C.V.	136.0	234.6	150.58	71.72	46.99	50.92	72.71	43.06	29.59	47.01	74.52	92.11	14.93

Source: Records of the Assistant Director of Statistics, Udhagamandalam soils of Udhagamandalam taluk are mostly red laterite formed from lateritic rocks. The fertility status is medium to high with limited nutritive retentive capacity due to its loose and friable soil structure. The soils are highly acidic (pH 4.6) and contain large amounts of iron and aluminium, which render the phosphates unavailable to plants. The texture varies from sand to clay, the soil being mainly loamy. The depth of the top soil varies from one foot to three feet while that of the sub-soil ranges upto fourteen feet. The porous nature of the sub-soil facilitates the cultivation of potato.

LAND USE PATTERN

The land utilisation pattern of Udhagamandalam taluk and the district are given in Table-V.

The table reveals that the total geographical area of the Nilgiris district is 2.54 lakh ha out of which Udhagamandamlam taluk occupies 1.19 lakh ha in the years 1984-85 and 1992-93. The net area cultivated constituted 22.8 per cent and 27.66 per cent in 1984-85 and 1992-93 respectively in the district as compared to 13.71 per cent and 15.7 per cent in 1984-85 and 1992-93 respectively in the taluk. It could also be seen that in 1984-85 nearly 20 per cent of the total geographical area of the district could be brought under plough as compared to 18.95 per cent at taluk level. However in 1992-93 only 8.76 per cent of the total geographical area of the district could be brought under plough as compared to ten per cent at taluk level.

TABLE-V

LAND UTILISATION PATTERN IN THE NILGIRIS DISTRICT AND UDHAGAMANDALAM TALUK

S.No.	Particulars	Area in hectares			
		1984-85		1992-93	
		Nilgiris	Udhagamandalam	Nilgiris	Udhagamandalam
1.	Total geographical area	254075 (100.0)	119768 (100.0)	254381 (100.0)	119764 (100.0)
2.	Forests	143200 (56.4)	80633 (67.34)	143359 (56.36)	80633 (67.33)
3.	Barren and uncultivable wastes	4620 (1.8)	2870 (2.4)	2712 (1.07)	1668 (1.39)
4.	Land put to non-agricultural use	9202 (3.6)	3481 (2.9)	8752 (3.44)	3138 (2.62)
5	Cultivable wastes	8548 (3.4)	1776 (1.48)	2876 (1.13)	1286 (1.07)
6.	Permanent pastures and grazing lands	6415 (2.5)	3016 (2.52)	4718 (1.85)	1838 (1.53)
7.	Land under miscellaneous tree crops and groves not included in net area sown	2093 (0.8)	1817 (0.85)	2206 (0.87)	1674 (1.40)
8.	Current fallows	14083 (5.5)	9126 (7.62)	11683 (4.59)	6945 (5.80)
9.	Other fallow lands	5470 (2.2)	1412 (1.18)	7722 (3.04)	3770 (3.15)
10.	Net area sown	60444 (22.8)	16437 (13.71)	70354 (27.66)	18812 (15.7)

Figures in parantheses indicate percentage to total geographical area.

Source : Records of the Assistant Director of Statistics, Udhagamandalam.

SIZE OF HOLDINGS

The number and area of operational holdings in Udhagamandalam taluk and Nilgiris district are given in Table-VI.

TABLE-VI

NUMBER AND AREA OF OPERATIONAL HOLDINGS IN THE NILGIRIS DISTRICT AND UDHAGAMANDALAM TALUK (1993)

Size of holding	NILGIRIS		UDHAGAMANDALAM	
	Number	Area (ha)	Number	Area (ha)
Below 0.25	2321 (4.93)	39.34 (0.046)	1178 (6.72)	21.01 (0.078)
0.25-0.50	18872 (40.09)	5913.03 (6.98)	5145 (29.36)	2155.54 (8.06)
0.50-1.00	12519 (26.59)	8177.39 (9.66)	5529 (31.55)	3496.64 (13.07)
1.00-2.00	7434 (15.79)	10182.97 (12.03)	2918 (16.65)	3724.74 (13.93)
2.00-3.00	2631 (5.58)	5968.27 (7.05)	1336 (7.62)	2869.00 (10.73)
3.00-4.00	1155 (2.45)	3827.38 (4.52)	553 (3.16)	1692.58 (6.33)
4.00-5.00	591 (1.25)	2677.79 (3.16)	298 (1.70)	1321.08 (4.94)
5.00-7.50	576 (1.22)	3452.21 (4.08)	212 (1.21)	1394.47 (5.21)
7.50-10.00	345 (0.73)	2841.13 (3.36)	132 (0.75)	1040.92 (3.89)
10.00-20.00	359 (0.76)	4707.28 (5.56)	139 (0.79)	1514.58 (5.66)
20.00-30.00 30.00-40.00 40.00-50.00 50.00 and above	265 (0.56)	36882.45 (43.56)	85 (0.49)	7514.49 (28.09)
Total	47068 (100.00)	84669.24 (100.00)	17525 (100.00)	26745.05 (100.00)

Figures in parantheses indicate percent to total
Source : Records of the Assistant Director of Statistics, Udhagamandalam.

It could be seen from the table that 87.4 per cent of the operational holdings in the Nilgiris district are less than two hectares in size and they accounted for 28.72 per cent of the area. In Udhagamandalam taluk 84.28 per cent of the holdings are less than two hectares in size and occupied 35.14 per cent of the area. This indicates that in both the district and study area more than 80 per cent of the farmers are marginal farmers.

The Gini concentration ratio for the Nilgiris district and Udhagamandalam taluk are 0.737 and 0.635 respectively showing that the distribution of operational holdings is highly skewed.

IRRIGATION

The variegated in situ rains throughout the year constitute the formation of rivers like Bhavani, Moyar, Kundah, Pykara and other streams of varying length which traverse the taluk and supplement water for irrigation and drinking purposes. Pykara, Moyar and Kundah rivers at high altitudes of this sub-division contribute for hydro-electric projects which play a significant role in the socio-economic conditions of the study area.

Crops are grown during the North-East and South-West monsoon periods under rainfed conditions. However, the crops grown in the summer season were irrigated from spring channels, wells and streams. Normally potato is cultivated during the North-East and South-West monsoon periods under rainfed conditions. The only source of irrigation in the study area was wells.

CROPPING SEASON AND CROPPING PATTERN

The cropping season of the the district could be divided into three seasons viz.,

First season : Jan-Feb to May-June (Irrigated crop)
Second season : Mar-Apr to Aug-Sept (Main crop)
Third season : Aug-Sept to Nov-Dec (Autumn crop)

The Nilgiris district is basically a horticulture district and the entire economy of the district depends on the success or failure of horticultural crops which in turn depend on the monsoon rains. Udhagamandalam taluk has an equitable distribution of rainfall for about 5-6 months in normal years. Annual crops like potato, cabbage, carrot, cauliflower and wheat are grown in this taluk and plantation crops are also cultivated to a considerable extent. Fruits like pears, plums and peach are also grown in small pockets of this taluk.The details are furnished in Table-VII.

It could be seen that nearly 74 per cent of the gross cropped area in Udhagamandalam taluk is occupied by plantation crops and the remaining by the annual crops. It could also be seen from the table that among the annual crops potato occupies the foremost position constituting 12.34 per cent of the gross cropped area in Uhagamandalam taluk, as compared to 4.0 per cent in the Nilgiris district during 1992-93.

TABLE-VII

AREA UNDER CROPS IN THE NILGIRIS DISTRICT AND UDHAGAMANDALAM TALUK-1992-93

(Area in hectares)

S.No.	Crop	Nilgiris	Udhagamandalam
1.	Potato	2866.62 (4.0)	2320.65 (12.34)
2.	Cabbage	796.00 (1.11)	539.00 (2.87)
3.	Carrot	1452.00 (2.02)	936.00 (4.98)
4.	Garlic	337.00 (0.47)	281.00 (1.49)
5.	Beetroot	75.00 (0.10)	-
6.	Cereals	1713.00 (2.39)	128.00 (0.68)
7.	Pulses	294.00 (0.41)	200.00 (1.06)
8.	Tea	46619.03 (65.06)	11663.03 (62.00)
9.	Coffee	9410.00 (13.13)	2350.00 (12.49)
	Gross cropped area	71659.00 (100.00)	18812.00 (100.00)

Figures in parantheses indicate percentage to gross cropped area
Source : Records of the Assistant Director of Statistics, Udhagamandalam.

POWER SUPPLY

Power is being generated from the hydel power stations of Pykara, Moyar and Kundah for consumption throughout the district.

A noteworthy feature of the Nilgiris district is that all the villages, towns and hamlets of the district have been electrified even before 1984.

SERVICE FACILITIES

There are service facilities for the distribution of seeds, fertilizers and plant protection chemicals in the Nilgiris district. There are as many as 54 dealers of seeds, 302 dealers of fertilizers and 210 dealers of plant protection chemicals in the district. Besides, Government agricultural depots are also supplying seeds, fertilizers and plant protection chemicals to the farmers of the district.

MARKETING FACILITIES

There are no regulated markets or weekly shandies in the Nilgiris district. However, there are five Co-operative marketing societies which include the District Co-operative Wholesale Society which are two in number, one Co-operative Vegetable Growers Society one Co-operative Marketing Society and a Co-operative Agricultural Farming Society.

Mettupalayam forms a principal wholesale market centre for potato. Continuous wet weather in the hills, lack of broad guage rail links and grading facilities are some of the reasons for marketing potatoes in Mettupalayam. The Nilgiris Co-operative Marketing Society (NCMS) and private commission agents at Mettupalayam normally undertake marketing activities. NCMS in general, accounts for about 40 per cent of the total produce and the remaining is shared by the other private commission agents.

TRANSPORT AND COMMUNICATION

Nilgiris district has a good network of roads running in all directions connecting the important centres of the district. The Coonoor ghat road which connects Mettupalayam and Coonoor forms the main communication link. The Siriyur ghat road starts from the northern crest of the plateau and passes through Masinagudi and Theppakadu and joins Gudalur and Mysore roads. Access to Calicut on the west can be had from Gudalur by a state highway (SH 8) passing through Cherambadi. The details of the road facilities available in the district is given in Table-VIII.

TABLE-VIII

DETAILS OF THE ROAD FACILITIES AVAILABLE IN THE NILGIRIS DISTRICT (1992-93)

(in km)

S.No.	Type of the road	Length
1.	State highways	152.30 (9.10)
2.	Major district roads	142.80 (8.53)
3.	Other district roads	611.497 (36.54)
4.	Panchayat Union roads	415.400 (24.82)
5.	Municipal roads	351.400 (20.99)
	Total length of roads	1673.397 (100.00)

Figures in parantheses indicate percentage to total length of roads.

Source : Records of the Assistant Director of Statistics, Udhagamandalam.

The total length of roads available in the Nilgiris district is 1673.4 kilometres of which the total length of roads in Udhagamandalam taluk is 274.33 km and it accounted for 16.39 per cent of total road length.

BANKING FACILITIES

The lead bank of the study area is the Canara bank. There are 28 bank branches functioning in Udhagamandalam taluk which includes 22 bank branches of nationalised banks, five Co-operative banks and one Primary Land Development bank. These banks provide the much needed financial assistance to the farmers.

The scale of finance and the details of crop loan per acre for the year 1993-94 provided by the Nilgiris District Central Co-operative Bank Ltd., Udhagamandalam is given in Table-IX.

TABLE-IX

SCALE OF FINANCE AND DETAILS OF CROP LOAN FOR THE YEAR 1993-94

(Amount in Rs)

S.No.	Crop particulars	Kind portion			Cash portion	Total
		Seeds	Fertilizers	Pesticides		
1.	Potato					
	Karbogam	2000	2200	900	2100	7200
	Kadaibogam	2000	2200	900	2100	7200
	Autumn	2000	2200	900	2100	7200
2.	Tea	-	2000	1000	1200	4200
3.	Coffee	-	800	400	2310*	3510
4.	Cabbage	1250	1560	1000	665	4475
5.	Carrot	500	1560	100	900	3060
6.	Garlic	3000	2080	400	1100	6580

* Including compound manure of Rs.800/-

Source : Annual Credit Plan 1993-94, Canara Bank

DEVELOPMENTAL SCHEMES:

To help the farming community, the Department of Horticulture is implementing the following Horticulture development schemes in the district.

1. Hill Area Development Programme (HADP)

The Hill Area Development Programme is being implemented in the Nilgiris district as an integrated programme from 1984-85 onwards on watershed basis. The main object of the programme is to prevent soil erosion in the hill slopes and to preserve the eco-system besides increasing the economic returns from unit area of land. The programme mainly involves diversification of cropping from annual crops like potato and vegetables to perennial crops like tea, fruit crops and economic trees which are not only more effective in preventing soil erosion but also providing better income to farmers.

2.Nilgiris Horticulture Development Programme

a) Potato Development Scheme

Under this programme, multiplication of quality potato seeds in government farms as well as in farmers holding is being carried out and distributed to a tune of 200 metric tonnes every year. In 1991-92 nearly 176.425 metric tonnes of potato seeds were made available for distribution to the farmers. A total amount of Rs 5.289 lakhs was spent towards this scheme during 1991-92.

b) Vegetable development scheme:

Under this scheme, quality seeds of various vegetables like carrot, radish, cauliflower, peas and beans are distributed to the vegetable growers. About 15-16 tonnes of high yielding vegetable seeds are distributed through the Horticulture Department annually covering about 800 hectares which accounts for 25.30 per cent of total area under vegetables in the district.

c) Crop improvement programme

Schemes like Hybrid Pepper scheme and Arecanut development scheme are also implemented in this district for improving the productivity of pepper and arecanut.

RESEARCH STATIONS

The following research stations are located in the Nilgiris district.

1. Central Potato Research Station, Muthorai, Udhagamandalam.
2. Horticultural Research Station, Udhagamandalam.
3. Central Soil and Water Conservation cum Training Institute, Udhagamandalam.
4. Wheat Breeding Research Station, Wellington.
5. Sheep Breeding Research Station, Udhagamandalam.

1. Central Potato Research Station(CPRS)

The CPRS is engaged in multi-disciplinary research on (i) breeding high yielding late blight and cyst nematode resistant varieties, (ii) developing suitable agronomic and manurial practices and (iii) conducting studies on diseases and pests of potato and evolving suitable management practices.

The CPRS has so far released three late blight resistant cultivars, ie., Cufri Neela in 1963, Cufri Neelamani in 1968 and Cufri Muthu in 1971 for cultivation. In addition, the late blight resistant cultivar Cufri Jyothi bred originally for North Indian hills has become very popular in this locality also. A culture SON-110 has been evolved which combines resistance to late blight and cyst rematodes and yields 15-25 per cent more than Cufri Jyothi. This hybrid is now being tested in adaptive research trials. Apart from this a research programme on true potato seeds (TPS) to study its suitability to the area is being carried out.

2. Horticulture Research Station (HRS):

The important activities of HRS include collection, maintenance and evaluation of varieties of cabbage, cauliflower, carrot, knol-khol, turnip and radish; selection and breeding to evolve varieties for adaptability, high yield, quality and resistance to pests and diseases and to evolve site specific crop rotation schedule to reduce the population of potato cyst nematode. Ooty 1 beetroot and Ooty 1 garlic varieties have been released from this research station.

From the foregoing, it is evident that Udhagamandalam taluk is associated with appropriate agro, socio and economic fabric for the development of the economy. However, there had been a declining trend in the area under potato.

RESULTS AND DISCUSSION

CHAPTER-V

RESULTS AND DISCUSSION

The present study attempts to analyse the trend in area, production and productivity of potato in the Nilgiris district, study the fluctuations in area under potato at the farmers level and isolate the factors for the same besides studying the yield gap in potato and constraints associated with it. In the back-ground of the agro-climatic features of the study area, data collected for the present study were analysed with reference to the above objectives and the results are presented and discussed in this chapter.

As mentioned elsewhere, 120 respondents were contacted in Udhagamandalam taluk of the Nilgiris district for the purpose of analysis. For carrying out a comparative analysis, the respondents were grouped into two different categories based on variation in the size of holdings and area under potato. The respondents were divided into farmers possessing a size of farm less than two hectares and those possessing more than two hectares of farm and progressive farmers since the analysis of variance exhibited marked differences between them. Discussion has been arranged in three sections. The first section deals with growth model analysis, the second section with the basic characteristic features of the sample households and the third with yield gap, constraint analysis and the results of the functional analysis made to identify the determinants of yield gap and their relative importance and implications for strategies to bridge the gap.

I. Growth Model

To evaluate the temporal movement in area, yield and production of potato in the Nilgiris district, (Figure 2) the Gompertz growth model is used. This is because the Gompertz growth curve can accomodate all the three: constant, diminishing and increasing growth rates. Besides, in the Gompertz model, the increments of its logarithms would increase or decrease by a constant percentage. That is, the rate of growth increases or decreases but not necessarily by either a constant amount or a constant percentage. The Gompertz curve is asymptotic at both ends, the lower asymptote being zero. The equation for the Gompertz curve is $Y = A \exp(-\exp(\alpha - \beta t)$ and the relative growth rate r is $\beta \exp(\alpha - \beta t) \times 100$.

A detailed analysis of the trend in area, production and productivity of potato in the Nilgiris district was carried out for three time periods, viz., 1955-56 to 1969-70; 1970-71 to 1992-93 and 1955-56 to 1992-1993 using Gompertz growth rate and the results are presented in Table-X.

Fig.2. Trend in Area, Production and Productivity of potato in the Nilgiris District

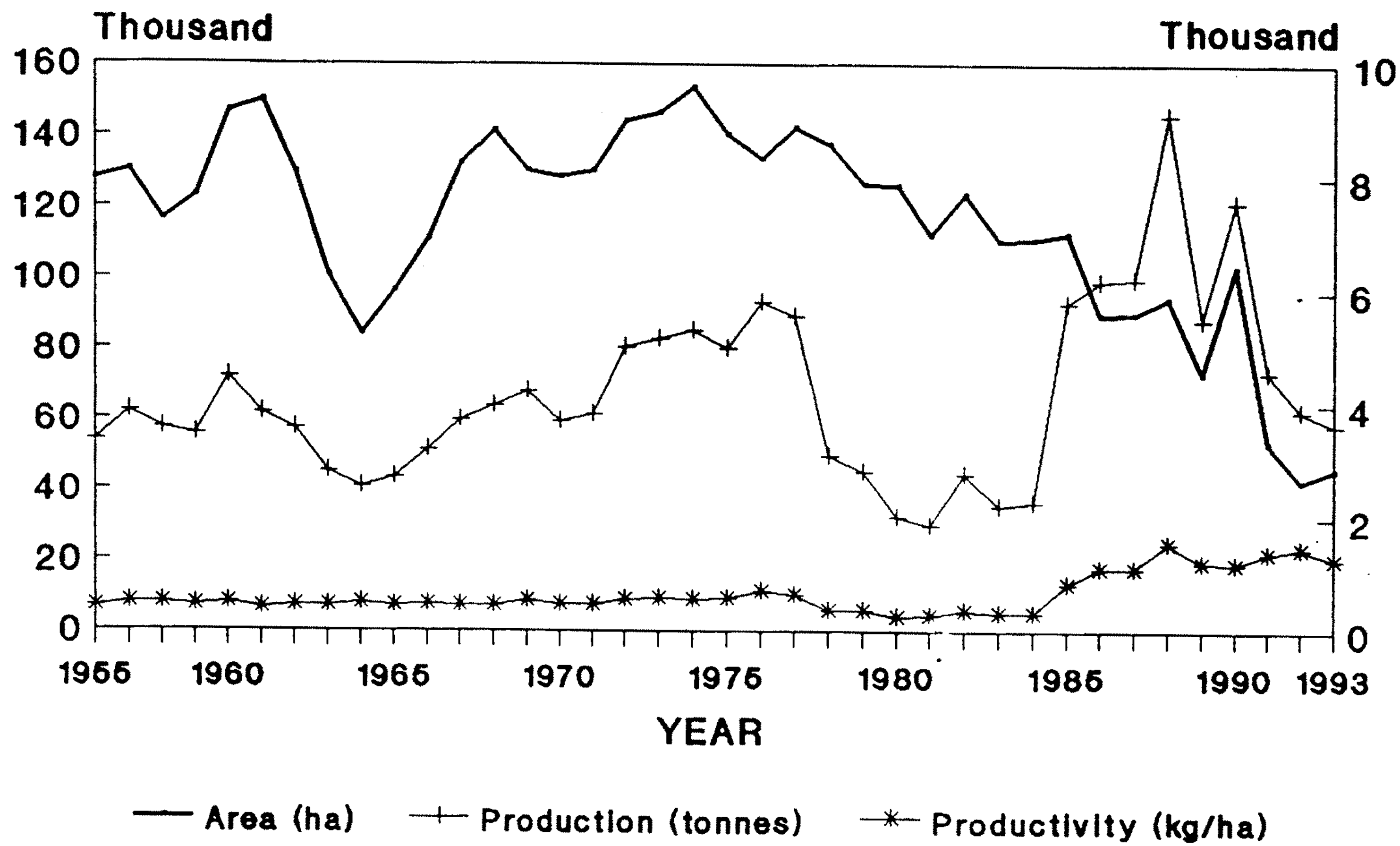


TABLE-X

GROWTH RATES USING GOMPERTZ MODEL

(in per cent)

S.No	Particulars	1955-'56 to 1969-'70	1970-'71 to 1992-'93	1955-'56 to 1992-'93
1.	Area	-0.4858	-0.1426	-0.2498
2.	Production	0.0219	1.3286	1.29
3.	Productivity	0.2827	1.8349	1.71

From the table, it could be seen that the growth rate of area has been showing a negative trend. Over the years, the area under potato has been declining considerably. During the pre-green revolution period ie., from 1955-56 to 1969-70, the relative growth rate was -0.4858 per cent and in the post green revolution period from 1970-71 to 1992-93, it was -0.1426 per cent. The overall trend for a period of 37 years commencing from 1955-56 shows a decline in area under potato over years (-0.2498 per cent). The reasons attributed for such decline are as under :

* Potato crop being sensitive to vagaries of weather and other diseases and infection as compared with other field crops, requires very careful upkeep of the crop;

* Potatoes are perishable in nature and therefore requires speedy and efficient marketing;

* Absence of mechanism for stabilising the price fluctuations.

* Because of differences of the economic status, the farmers normally adjust their area under potato to avoid such risks in potato cultivation.

* Another alarming reason for the decline of area under potato is conversion of potato lands to non agricultural uses like construction of residential buildings and other industrial usages.

Due to the above mentioned reasons, farmers are gradually shifting the area from potato to cultivation of plantation crops especially to tea as evidenced in the growth rates of area under tea in the Nilgiris district. Further there had been increased area under carrot and cabbage also. The compound growth rates for area under tea in the Nilgiris district worked out for three time periods viz., 1970-'71 to 1980-81; 1981-'82 to 1992-'93 and 1970-71 to 1992-'93 was found to be 0.4 per cent, 5.43 per cent and 4 per cent respectively. Besides, a single crop of tea can be maintained upto ten years before first pruning. Apart from this the Government is alloting large subsidies to tea growers whereas such subsidies are not seen for potato.

The production and productivity of potato however shows a positive trend over years. Growth rate for production shows a positive trend of 1.29 per cent over years while that of productivity is 1.71 per cent. The introduction of improved technology in agriculture, adoption of improved potato strains such as Cufri Jyothi, inception of the Indo-German Nilgiris Development Project, formation of the Horticulture Department and operation of NCMS (Nilgiris Co-operative Marketing Society) and NVGC (Nilgiris Vegetable Growers Co-operative), improved transportation systems and other infra-structural facilities could have contributed to increase in productivity and production.

Even though there existed reasonably good growth rates in production and productivity, yet there existed differences in yield realisation among different categories of farmers and the details are presented in what follows.

II BASIC CHARACTERISTICS OF THE SAMPLE HOUSE-HOLDS

1 Distribution of respondents

As mentioned elsewhere, the sample respondents were post stratified into small and large farmers taking into consideration the size of the farm. Thus in all there were 55 small farmers and 35 large farmers among the selected respondents.

The villagewise distribution of the sample respondents in the study area is presented in Table XI.

TABLE XI

DISTRIBUTION OF RESPONDENTS

S.No.	Name of villages	Small farmers	Large farmers	Total farmers	Progressive farmers
1	Hullathi	15 (27.27)	-	15 (16.67)	5 (16.67)
2.	Ithalar	9 (16.36)	6 (17.14)	15 (16.67)	5 (16.67)
3.	Kagguchi	15 (27.27)	-	15 (16.67)	5 (16.67)
4.	Mulligoor	7 (12.73)	8 (22.86)	15 (16.67)	5 (16.67)
5.	Naduvattam	8 (14.55)	7 (20.00)	15 (16.67)	5 (16.67)
6.	Nanjanad	1 (1.82)	14 (40.00)	15 (16.67)	5 (16.67)
	Total	55 (100.00)	35 (100.00)	90 (100.00)	30 (100.00)

Figures in parantheses indicate percentage to total.

From the table it is evident that the distribution of small farmers among sample respondents varied from 1.82 per cent in Nanjanad village to 27.27 per cent in Hullathi and Kagguchi villages. Similarly, the distribution of large farmers among the sample respondents ranged from 17.14 per cent in Ithalar village to 40.00 per cent in Nanjanad village. As regards progressive farmers, no categorisation was resorted to and in all thirty progressive farmers, as mentioned earlier, constituted the sample framework.

2. Farm size of sample respondents

The farm size of the sample farmers, size groupwise, is given in Table XII.

TABLE-XII

FARM SIZE OF SAMPLE RESPONDENTS

(Area in hectares)

S.No.	Size group	Number of respondents	Total extent of the farm	Average size of the farm
1.	Small farmers	55	57.2 (42.40)	1.04
2.	Large farmers	35	77.7 (57.59)	2.22
	Total	90	134.9 (100.00)	1.49
3.	Progressive farmers	30	72.8	2.43

Figures in parantheses indicate percentage to total.

It could be seen from the table that the total size of the sample farms accounted to 134.9 hectares. About 42 per cent of the total size of the farm is accounted for by the small farmers and the remaining by large farmers. The average size of the small farms and large farms worked out to be 1.04 and 2.22 hectares respectively and the overall size of the farm for the entire sample framework was found to be 1.49 hectares. The average size of farm of the progressive farmers worked out to be 2.43 hectares. In general, the progressive farmers have comparatively larger area under operation.

3. Literacy level of respondents

The literacy level of the sample respondents in the study region is given in Table XIII.

TABLE XIII

LITERACY LEVEL OF THE RESPONDENTS

S.No.	Status	Small farmers	Large farmers	Total farmers	Progressive farmers
1.	Primary	-	-	-	-
2.	Middle school	1 (1.81)	-	1 (1.11)	-
3.	High school	20 (36.36)	4 (11.43)	24 (26.67)	6 (20.00)
4.	Higher Secondary	21 (38.18)	10 (28.57)	31 (34.44)	12 (40.00)
5.	Collegiate	13 (23.64)	21 (60.00)	34 (37.78)	12 (40.00)
	Total	55 (100.00)	35 (100.00)	90 (100.00)	30 (100.00)

Figures in parantheses indicate percentage to total.

It is evident that most of the small farmers in the study region were educated upto higher secondary level accounting for 38.18 per cent. Nearly 37 per cent were educated upto high school, 23.64 per cent upto collegiate level and only 1.81 per cent upto middle school. Among the large farmers, 60.00 per cent were educated upto collegiate level. In all, nearly 72 per cent of the respondents had their education level beyond high school level. Another interesting feature is that none of the sample respondents were illiterates. In the case of progressive farmers nearly 80 per cent of the respondents studied beyond high schools. Perhaps this might be one of the reasons for their better position in the cultivation of potato as compared to their counterparts in the sample framework. Education has considerably influenced the adoption of recommended practices in potato cultivation and the resultant yield gap was considerably low in the category of progressive farmers.

4. Asset position

The sample respondents maintained different types of asset such as land, buildings, deadstock and livestock. The different types of asset maintained by the respondents alongwith their value are shown in Table XIV.

From the table it is evident that land is the most important asset held by the respondents accounting for more than 50 per cent of the total asset held by the farmers in the study area. While for the entire study region, land constituted 49.47 per cent of the

TABLE XIV

ASSET POSITION OF SAMPLE RESPONDENTS

(Amount in Rs)

S.No.	Assets position	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare
1.	Land	59335.27	57053.14	66688.57	30039.89	59298.78	39797.84	78450.07	32283.97
		(55.09)	(55.09)	(47.98)	(47.98)	(49.47)	(49.47)	(54.67)	(54.67)
2.	Buildings	34300.00	32980.77	59241.43	26685.33	46895.56	31473.53	47933.35	19725.65
		(31.85)	(31.85)	(42.62)	(42.62)	(39.12)	(39.12)	(33.41)	(33.41)
3.	Deadstock	6774.95	6514.38	8415.86	3790.93	7413.08	4975.22	10417.33	4286.96
		(6.29)	(6.29)	(6.05)	(6.05)	(6.18)	(6.18)	(7.26)	(7.26)
4.	Livestock	7288.00	7007.69	4648.87	2094.09	6261.67	4202.46	6690.00	2753.08
		(6.77)	(6.77)	(3.34)	(3.34)	(5.22)	(5.22)	(4.66)	(4.66)
	Total	107698.22	103555.98	138994.73	62610.24	119869.09	80449.05	143490.73	59049.66
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Figures in parantheses indicate percentage to total

total asset, for the progressive farmers, land asset constituted nearly 55.00 per cent. Buildings are the next important asset held by the respondents. Buildings constituted 39.12 per cent of the total asset for the sample respondents and it is 33.41 per cent for the progressive farmers.

Deadstock which included hand-operated and power operated equipments accounted for 6.18 per cent of the total asset of sample respondents and it is 7.26 per cent for the progressive farmers. Livestock shared only around 3 to 6 per cent of the asset held by the farmers in the study area.

It could be concluded that land accounted for a greater share in the total asset among the farmers in the study area. Further there existed wide variation in the asset held by the progressive farmers and other categories of farmers on per farm basis. However on per hectare basis, small farmers were comparitively in a better position as compared to large farmers and progressive farmers since the relative share of the asset is comparatively higher than their counterparts of the other two categories of farmers

5. Cropping pattern

The details of cropped area held by the farmers in the study area is given in Table XV.

From the table, it could be seen that net area sown per farm was highest in the case of progressive farmers with 2.43 hectares followed by large farmers (2.22 hectares) and small farmers (1.04 hectares). Area sown more than once was also found to be highest

TABLE XV

DETAILS OF CROPPED AREA

(Area in hectares)

S.No.	Cropping pattern	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare
1.	Net area sown	1.04	1.00	2.22	1.00	1.49	1.00	2.43	1.00
2.	Area sown more than once	0.84	0.81	0.59	0.27	0.75	0.50	1.56	0.64
3.	Gross cropped area	1.88	1.81	2.81	1.27	2.24	1.50	3.99	1.64
4.	Cropping intensity(%)	180.76	181.00	126.58	127.00	150.00	150.00	164.19	164.00

for progressive farmers, the area being 1.56 hectares per farm as compared to 0.75 hectares for the sample potato growers. As regards the cropping intensity, the small farmers had an edge over the large farmers and progressive farmers in the study region, the cropping intensity being 180.76 per cent, 126.58 per cent and 164.19 per cent for the small farmers, large farmers and progressive farmers respectively.

6. Area under different crops

The area under different crops raised by the sample respondents is given in Table-XVI.

From the table it could be seen that the major crops cultivated were potato, cabbage, carrot and tea. The other crops being grown include beetroot, beans, peas, garlic, radish and oats for fodder purpose. On an average, of the gross cropped area of 2.24 hectares of the sample respondents, potato was cultivated in 27.68 per cent of the area followed by cabbage, tea and carrot in 25.45, 25.00 and 12.50 per cent of the area respectively. Similarly among the 30 progressive farmers contacted, 28.82 per cent of their gross cropped area was occupied by potato, followed by cabbage (25.06 per cent), tea (22.81 per cent) and carrot (14.29 per cent). It is therefore evident that though there had been reduction in potato area over years, still it dominated the cropping pattern of the farmers irrespective of the size differentials.

TABLE XVI

AREA UNDER DIFFERENT CROPS IN THE STUDY AREA

(Area in hectares)

S.No.	Crops	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare
1.	Potato	0.37 (19.79)	0.20 (20.00)	1.02 (36.29)	0.36 (36.00)	0.62 (27.68)	0.28 (28.00)	1.15 (28.82)	0.29 (29.00)
2.	Cabbage	0.43 (22.46)	0.23 (23.00)	0.81 (28.83)	0.29 (29.00)	0.57 (25.45)	0.25 (25.00)	1.00 (25.06)	0.25 (25.00)
3.	Carrot	0.29 (15.51)	0.15 (15.00)	0.27 (9.61)	0.10 (10.00)	0.28 (12.5)	0.13 (13.00)	0.57 (14.29)	0.14 (14.00)
4.	Beetroot	0.05 (2.69)	0.03 (3.00)	0.05 (1.78)	0.02 (2.00)	0.05 (2.23)	0.02 (2.00)	0.07 (1.75)	0.02 (2.00)
5.	Beans	0.04 (2.14)	0.02 (2.00)	0.04 (1.42)	0.01 (1.00)	0.04 (1.79)	0.02 (2.00)	0.11 (2.96)	0.03 (3.00)
6.	Peas	0.01 (0.53)	0.005 (0.5)	0.02 (0.71)	0.007 (0.7)	0.02 (0.89)	0.008 (0.8)	0.03 (0.75)	0.007 (0.07)
7.	Garlic	0.14 (7.49)	0.07 (7.00)	-	-	0.09 (4.02)	0.04 (4.00)	0.14 (3.51)	0.04 (4.00)
8.	Oats	0.0018 (0.096)	0.0009 (0.09)	0.01 (0.36)	0.004 (0.4)	0.0056 (0.25)	0.002 (0.2)	0.0067 (0.17)	0.001 (0.01)
9.	Radish	-	-	0.057 (0.20)	0.002 (0.20)	0.0022 (0.098)	0.009 (0.09)	-	-
10.	Tea	0.55 (29.61)	0.29 (29.00)	0.59 (20.99)	0.21 (21.00)	0.56 (25.00)	0.25 (25.00)	0.91 (22.81)	0.23 (23.00)
	Total	1.88 (100.00)	1.00 (100.00)	2.81 (100.00)	1.00 (100.00)	2.24 (100.00)	1.00 (100.00)	3.99 (100.00)	1.00 (100.00)

Figures in parantheses indicate percentage to total

7. Irrigation pattern

The details of irrigation practices of the sample respondents are furnished in Table-XVII.

The only source of irrigation of the sample respondents is wells. The well irrigated area per farm for the entire study region was 0.75 hectares and the irrigated area accounted for 50.34 percent of the total operational area of the farm. In the case of the progressive farmers, the irrigated area was 1.28 hectares and it formed 52.67 per cent of the total operational area of the farm. Since no area was irrigated more than once, the irrigation intensity for all the three size groups of farmers viz., small, large and progressive farmers worked out to be 100 percent only.

8. Periodicity of cropping pattern

The cropping pattern of any study region is influenced by natural factors like climate and rainfall, cultural factors like cultivation practices, technological factors like improved or high-yielding varieties and package of practices and economic factors like price and market structure and infra-structural facilities like transportation, storage, banking, etc. An analysis of periodicity of cropping pattern would help to know the level of agricultural development and its strength or otherwise. The details of the periodicity of the cropping pattern of the sample respondents in the study region is given in Table-XVIII.

TABLE XVII

IRRIGATION PATTERN

(Area in hectares)

S No.	Irrigation pattern	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare
1.	Well irrigated area	0.57	1.00	0.65	1.00	0.75	1.00	1.28	1.00
2.	Net area irrigated	0.57	1.00	0.65	1.00	0.75	1.00	1.28	1.00
3.	Area irrigated more than once	-	-	-	-	-	-	-	-
4.	Gross area irrigated	0.57	1.00	0.65	1.00	0.75	1.00	1.28	1.00
5.	Per cent to total operational area	54.81	96.15	29.28	45.05	50.34	67.11	52.67	41.15
6.	Irrigationintensity	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

TABLE XVIII

PERIODICITY OF CROPPING SYSTEM

S.No.	Periodicity of cropping pattern (years)	Small farmers	Large farmers	Total farmers	Progressive farmers
1.	< 5	5	2	7	7
		(9.09)	(5.71)	(7.78)	(23.33)
2.	5-10	39	24	63	14
		(70.91)	(68.57)	(70.00)	(46.67)
3.	> 10	11	9	20	9
		(20.00)	(25.71)	(22.22)	(30.00)
	Total	55	35	90	30
		(100.00)	(100.00)	(100.00)	(100.00)

Figures in parantheses indicate percentage to total

The cropping pattern followed by the respondents in the study region in general was potato-cabbage-carrot/beetroot. This cropping pattern is being followed by 20.0 and 25.71 per cent of the sample small and large farmers respectively for more than ten years as compared to 22.22 per cent of the total sample respondents. On the contrary, 30 per cent of the chosen progressive farmers followed the afore said cropping pattern for more than ten years. In sum, 92 per cent of the sample respondents viz., ordinary potato growers in the study region followed the afore said cropping pattern for more than five years as compared to 76.67 per cent among the progressive farmers. Thus it evident that potato is being cultivated continuously by all the sample respondents over years.

9. Changes in area under potato over years

Though the cropping pattern is being followed by the majority of the sample respondents for more than five years, yet there has been perceptible change in the the area under different crops of the cropping pattern. The percentage change in area under crops during the last five years is presented in Table-XIX.

The drastic decline in area under potato in the study area is evident from the above table. The per cent decline in area under potato for the sample respondents for the entire study region was 57.76 and it varied from 57.59 in the case of small farmers to 58.17 in the case of large farmers. Thus it could be seen that the percentage decline in area under potato was comparatively more pronounced in the case of small farmers as compared to the large farmers. In the case of progressive farmers, though, there was decline in the area under potato, yet it is comparatively low as compared to the ordinary potato growers in the study region. Thus all the sample respondents have reduced their area under potato during the last five years.

10. Reasons for shift to other crops

As mentioned earlier, the area under crops like cabbage, tea and carrot is on the increase in the study area. The sample respondents were asked to rank the reasons for shift from potato to other crops and the results are furnished in Table XX.

It could be seen from the table that all the respondents in the study area attributed high cost of cultivation as the major

TABLE XIX

CHANGES IN AREA UNDER POTATO OVER YEARS

(Area in hectares)

S.No.	Change in Area	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare
1.	Area under potato in the last 5 yrs	2.24	1.00	3.61	1.00	2.77	1.00	3.63	1.00
2.	Area during the period of study	0.95	0.42	1.51	0.42	1.17	0.42	1.97	0.54
3.	% change	-57.59	-58.00	-58.17	-58.00	-57.76	-58.00	-45.73	-46.00

TABLE XX

REASONS FOR SHIFT TO OTHER CROPS

S.No.	Reasons	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
1.	High cost of cultivation	61.62	I	60.69	I	61.30	I	61.6	I
2.	Fluctuating prices	41.86	II	41.87	II	41.86	II	40.9	III
3.	Lack of marketing & storage facilities	35.00	IV	-	-	35.00	IV	47.0	II
4.	High incidence of pests and diseases	35.47	III	35.9	III	35.62	III	35.17	IV

reason for shift to other crops from potato with a mean score of 61.62. The second important reason attributed for the shift by the small and large farmers was fluctuating prices, the score being 41.86 and 41.87 respectively. On the contrary, the second major reason attributed by progressive farmers for the shift in cropping pattern was lack of marketing and storage facilities. No cold storage facilities are available for potato in the Nilgiris district inspite of it being a semi-perishable crop.

11. Reasons for choice of variety

The only variety of potato cultivated in the study area is Cufri Jyothi. Cufri Jyothi is a high yielding variety with moderate resistance to late blight disease of potato. The reasons for choice of this variety are furnished along with the ranks assigned by the respondents in Table XXI.

The main reason attributed by the sample farmers in the study area is that it is the only available variety (mean score 53.22). The second important reason is that it is a high yielder (mean score of 50.86). Similarly, the progressive farmers opined that they are cultivating Cufri Jyothi because of its high yield. The suitability of the variety to the tract and pest and disease tolerance ranked third and fourth reasons for the choice of Cufri Jyothi.

TABLE XXI

REASONS FOR CHOICE OF VARIETY

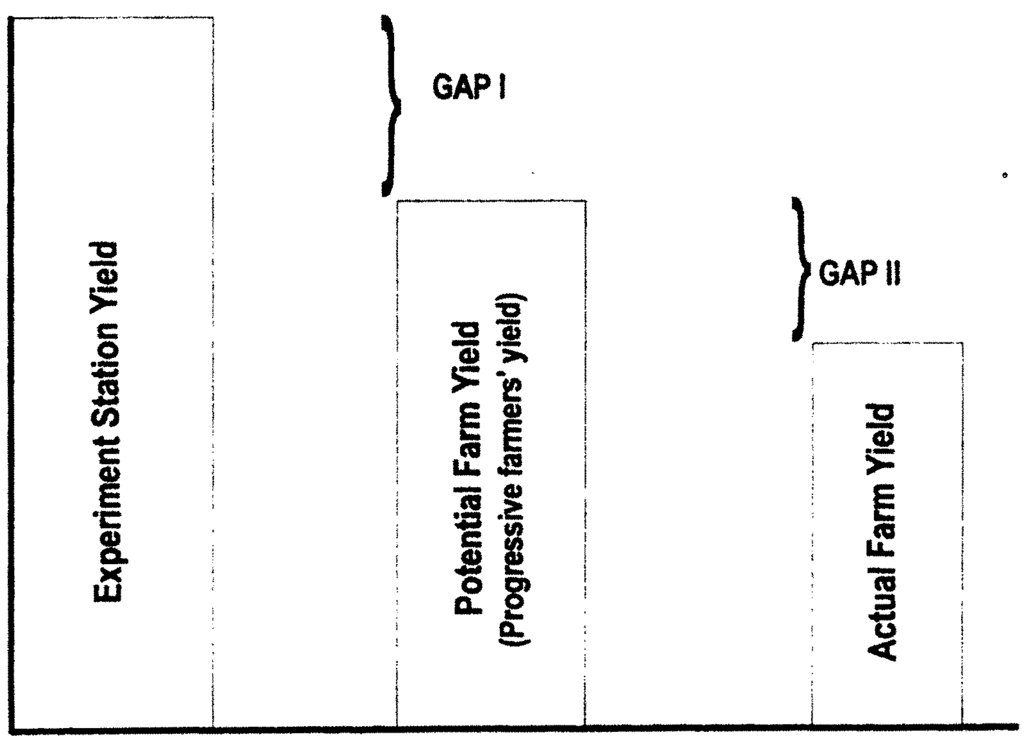
S.No.	Reasons	Small farmers		Large farmers		Total farmers		Progressive farmers	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
1.	High yield	51.14	II	50.54	II	50.86	II	55.87	I
2.	Pest and disease tolerance	47.50	III	33.00	IV	38.8	IV	35.50	IV
3.	Suitability for tract	4.87	IV	44.44	III	41.71	III	39.60	III
4.	Only available variety	51.82	I	55.00	I	53.22	I	54.00	II

IIIa) YIELD GAP OF POTATO

The adoption of scientific technology in farming aims at increasing the production of both irrigated and rainfed crops by toning up productivity. But in reality due to the operation of a number of technical, social and economic constraints at the farm level, farmers have not yet realised the full potential of output as anticipated by using the available technology and this virtually resulted in yield gap.

In the context of the limited and shrinking supply of land resource, it is imperative to identify the determinants of yield gap and to remove them by pragmatic policy support. Total gap in yield can be separated into two components: yield gap I is the difference in the level of productivity attained in the Horticultural research station, which represents the physical maximum possible yield (taken as potential yield for the study) under the existing technology and resource situation and maximum yield obtained in the farmer's field. This gap would hence reveal the barriers to transfer of technology. Yield gap II is the difference between maximum farm yield and actual yield of individual farmers. This is largely due to the managerial differences in crop management practices and it would reflect the constraints to the adoption of technology. A conceptual model of yield gap is given in Figure 3. The yield gap in potato crop in the study area is given in Table XXII.

FIG. 3 : CONCEPTUAL MODEL FOR YIELD GAP



GAP I

*Controlled environment
* Better inputs
* Better management

GAP II

a) TECHNICAL CONSTRAINTS :

* Lack of suitable varities
* Water scarcity in first season
* Pests and diseases

b) SOCIO ECONOMIC CONSTRAINTS :

* Lack of owned funds
* Poor quality inputs
* High cost of inputs
* Non-availability of inputs
* Unfavourable market & storage facilities

TABLE XXII

YIELD GAP OF POTATO

(in kg/ha)

S.No	Particulars	Small famers	Large famers	Total famers	Progressive famers
1.	Experimental station yield	71,800	71,800	71,800	71,800
2.	Maximum yield of farmers	26,250	30,000	30,000	40,500
3.	Average yield of farmers	11,818.18	21,557.14	15605.56	32116.67
4.	Gap I	45,550 (63.37)	41,800 (58.22)	41,800 (58.22)	31,300 (43.59)
5.	Gap II	14,431.82 (54.98)	8442.86 (28.14)	14394.44 (47.98)	8383.33 (20.69)

Figures in parantheses indicate percentage of yield gap

It could be seen from the table that there existed considerable yield gap in potato crop. It is observed that gap I is higher than gap II.

Yield gap I is highest among small farmers (45,550 kg/ha) followed by large farmers with a gap of 41,800 kg/ha. The gap I is lowest for progessive farmers (31,300 kg/ha). In terms of percentage, yield gap I is 63.37, 58.22 and 43.59 for small, large and progressive farmers respectively. Yield gap I is caused by slack in transfer of technology. Therefore, a more effective technology transfer system would enable the farmers to have better access to the modern technology and to motivate and convince them to readily accept and adopt the crop production techniques generated in the research institutes. This warranted concerted efforts on the part of extension agencies who serve as a connecting link between scientists and farmers.

Yield gap II is 14,431.82 kg/ha for small farmers followed by 8442.86 kg/ha for large farmers. Gap II is lowest among progressive farmers, the gap being 8383.33 kg/ha.

In per cent terms yield gap II is highest among the small farmers accounting for 54.98 per cent, followed by 28.14 per cent for large farmers and 20.69 per cent for progressive farmers. This indicates that the constraints to adoption of technology among small farmers is the highest. As mentioned elsewhere yield gap II is the difference between maximum farm yield and actual yield of individual farmers. Maximum yield obtained by one farmer can be realised by other farmers in the similar agro-climatic conditions. Yet there were inter-farm differences in yield due to specific farm constraints that affected managerial efficiency of farmers. Hence, the difference between the maximum yield realised among the sample farms and the actual yield realised by the farmer was called 'management gap'. This gap has to be bridged by appropriate policies that would facilitate decision making of farmers such as price policy, input supply policy, infra-structural development and training of farmers to impart skill necessary to understand and use the new technology.

IIIb) CONSTRAINTS

The constraints faced by the farmers in the study area were classified into two types viz., technical constraints and socio-economic constraints. The technical constraints included lack of suitable varieties, water problem, poor quality inputs and pest and disease problem while the socio-economic constraints included lack of owned funds, high cost of inputs, non-availability of inputs, unfavourable marketing facilities and lack of storage facilities. The constraints faced by the respondents in the study area in potato cultivation are analysed and ranked using Garrett ranking technique. The results are presented in Table XXIII.

TABLE XXIII

TECHNICAL CONSTRAINTS IN POTATO CULTIVATION

S.No	Reasons	Small		Large		Total		Progressive	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
1.	Lack of suitable varieties	47.13	III	53.88	I	50.5	I	47.5	III
2.	Water problem in the first season	50.5	II	43.75	III	46.0	III	58.88	I
3.	Pests and Diseases problem	50.58	I	50.17	II	50.42	II	48.07	II

Lack of suitable varieties with a mean score of 50.5 was the major problem expressed by small and large farmers followed by pest and diseases problem with a mean score of 50.42 and water problem in the first season with a mean score of 46.0. As mentioned earlier Cufri Jyothi is the only variety of potato available to the farmers. Though it is a high yielder, yet it has 25-30 per cent susceptibility to late blight disease. Besides golden yellow nematode problem still persists in the study area. Further, of late wild boar are becoming an increasing menace in the study area which cause extensive damage to potato crop.

Progressive farmers have however indicated water problem in the first season as the major constraint with a mean score of 58.88 followed by the problem of pests and diseases and lack of suitable varieties. Since wells are the only source of irrigation, when they dry out in the summer season this crop is to be entirely rainfed in the second and third season.

The socio-economic constraints that are faced by the small, large and progressive farmers are presented in Table XXIV.

TABLE XXIV

SOCIO-ECONOMIC CONSTRAINTS IN POTATO CULTIVATION

S.No	Reasons	Small		Large		Total		Progressive	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
1.	Lack of owned funds	27.0	VI	58.0	II	42.5	III	-	-
2.	Poor quality inputs	43.33	II	47.5	III	45.0	II	50.0	II
3.	High cost of inputs	66.07	I	66.94	I	66.41	I	64.87	I
4.	Non-availability of inputs	40.00	IV	31.00	V	35.5	V	31.67	V
5.	Unfavourable marketing facilities	41.07	III	42.60	IV	41.67	IV	41.64	III
6.	Lack of storage facilities	33.33	V	29.71	VI	31.59	VI	34.56	IV

Among the different categories of farmers, the major problem faced by the respondents was the high cost of inputs. For the small farmers, the major constraint was high cost of inputs (with a mean score of 66.07) followed by poor quality of inputs (43.33), unfavourable marketing facilities (41.07), non-availability of inputs (40.00) lack of storage facilities (33.33) and lack of owned funds (27.0) in that order.

Large farmers expressed high cost of inputs as the main constraint with a mean score of 66.94. The second major constraint faced by them was lack of owned funds (58.0). The other problems were poor quality inputs, unfavourable marketing facilities, non-availability of inputs and lack of storage facilities.

Among the progressive farmers also, high cost of inputs was the major constraint with a mean score of 64.87. They ranked poor quality inputs, unfavourable marketing facilities, lack of storage facilities and non-availablity of inputs as second, third, fourth and fifth problems with mean score values of 50.0, 41.64, 34.56 and 31.7 respectively.

In general, high cost of inputs, poor quality of the inputs and lack of owned funds for carrying out the timely operations were the major socio-economic problems confronted by the potato growers in the study region.

IIIc) FUNCTIONAL ANALYSIS

In the present study, yield gap II is defined as the difference in the yield levels in the farmers field and the maximum obtained from among the famers contacted. To identify the factors contributing to it and to assess the magnitude of their influence on yield gap II, a functional analysis was carried out. The underlying basic assumption was that the recommended levels of application of inputs would yield the maximum yield realised on the farm. This assumption was confirmed to be valid by the fact that the farmer who harvested the maximum yield had used the recommended doses of inputs. The deviation of actually realised yield of potato crop from this maximum yield (yield gap II) could then be related to the deviation of actual levels of input use from the recommended levels. Therefore, yield gap II was regressed on deviations in the quatity of inputs used viz., seed rate, quantity of farmyard manure applied, quantity of potato mixture applied and quantity of plant protection chemical. Besides these, the number of irrigations actually followed by the respondents and the educational level of the respondents measured in actual years of schooling were also taken into account since there existed marked deviation in these two exogenous variables among the different categories of farmers. The scatter of the observations indicated that the relationship between regressors and regressed was linear. Hence linear functional analysis was resorted to with yield gap as the dependent variable and deviations in the quantity of inputs used as independent variables.

The estimated yield gap functions for small, large and progressive farmers are presented in a tabular form and discussed hereunder.

i) Small farmers : The findings of the yield gap function for small farmers is discussed in Table XXV and the estimated function is presented below.

$$\hat{Y} = 2653.2 + \underset{(1.287)}{2.1257}\, X_1 + \underset{(5.632)}{10.7740}\, X_2 + \underset{(0.4417)}{0.6254}\, X_3 + \underset{(4.676)}{9.9697}\, X_4^{*} +$$

$$\underset{(371.4)}{865.14}\, X_5^{*} + \underset{(0.4111)}{0.6007}\, X_6$$

$R^2 = 0.358$ $\quad \hat{R}^2 = 0.269$ $\quad n = 43$

** Significant at 1 per cent level
* Significant at 5 per cent level

TABLE XXV

ESTIMATED REGRESSION CO-EFFICIENTS OF THE YIELD GAP FUNCTION

(SMALL FARMERS)

S.No.	Variable	Regression co-efficient	't' statistic
1.	Intercept	2653.2	-
2.	Seed rate (kg/ha)	2.1257	1.652
3.	Number of irrigations	10.7740	1.913
4.	Farmyard manure (kg/ha)	0.6254	1.416
5.	Potato mixture (kg/ha)	9.9697	2.132*
6.	Plant protection chemicals (kg/ha)	865.14	2.329*
7.	Education (number of years of schooling)	0.6007	1.461

R^2 = 0.358
F = 0.400

Note : ** Significant at 1 per cent level
* Significant at 5 per cent level

The co-efficient of multiple determination (R^2) was 0.36 indicating that 36 per cent of the variation in yield gap could be explained by the vector of independent variables included in the linear model.

The co-efficent of potato mixture was 9.9697 and significant at five percent level. It implied that one kg increase in potato mixture <u>ceteris</u> <u>paribus</u> would narrow down the yield gap by 9.9697 kg. This shows that potato mixture is underutilised in small farms and there is scope for bridging the yield gap through increase in application of potato mixture from its mean level of application. The reasons for this might be due to the relatively high cost of potato mixture and non-availability of potato mixture on time to the small farmers.

The co-efficient of plant protection chemicals was 865.14 and significant at five per cent level. This implied that an increase of plant protection chemical by one kg *ceteris paribus* would reduce the yield gap by 865.14 kg. The high cost of plant protection chemicals is the reason for under utilisation of plant protection chemicals.

The seed rate, number of irrigations, farmyard manure and educational status do not have any significant influence on the yield gap.

The adoption gap potato could be bridged by increased usage of potato mixture and plant protection chemicals.

ii) Large farmers: The yield gap function results of large farmers is tabulated in Table XXVI and the estimated function is presented below.

$$\hat{Y} = 15882 + \underset{(2.459)}{3.8202}\, X_1 + \underset{(936.8)}{994.54}\, X_2 + \underset{(0.1723)}{1.3746}\, X_3^{**} + \underset{(2.100)}{4.4761}\, X_4^{*} +$$

$$\underset{(462.7)}{160.59}\, X_5 + \underset{(5.214)}{1.6075}\, X_6$$

$R^2 = 0.4031$ $\quad \hat{R}^2 = 0.3719$ $\quad n = 28$

** Significant at 1 per cent level

* Significant at 5 per cent level

TABLE XXVI

ESTIMATED REGRESSION COEFFICIENTS OF YIELD GAP FUNCTION

(LARGE FARMERS)

S.No.	Variable	Regression co-efficient	't' statistic
1.	Intercept	15882	-
2.	Seed rate (kg/ha)	3.8202	1.554
3.	Number of irrigation	994.54	1.062
4.	Farm yard manure (kg/ha)	1.3746	7.979**
5.	Potato mixture (kg/ha)	4.4761	2.132*
6.	Plant protection chemicals (kg/ha)	160.59	0.347
7.	Education (Number of years of schooling)	1.6075	0.3083

R^2 = 0.4031
F = 0.1914

Note : ** Significant at 1 per cent level
* Significant at 5 per cent level

The co-efficient of multiple determination (R^2) was 0.40 indicating that 40 per cent of the variation in yield gap could be explained by the independent variables included in this function. All parameters had the _a priori_ expected sign and therefore the estimated equation was valid for interpretation.

The co-efficient of farmyard manure was 1.3746 and significant at one per cent level, implying that by increasing the application of farmyard manure by one kg _ceteris paribus_ the yield gap could be reduced by 1.37 kg . This indicates the low usage of farmyard manure by the large farms. It is interesting to note that this variable is non-significant for small farms probably because small farmers owned a larger number of livestock compared to large farmers and used the manure in their own fields.

The co-efficient of potato mixture was 4.4761 and significant at five per cent level. It implied that an increase of potato mixture by one kg would reduce the yield gap by 4.4761 kg . This implies that there is scope for bridging the yield gap through increased application of potato mixture from its mean level of application.

The co-efficient of seed rate, number of irrigations, plant protection chemicals and education level were found to be non-significant and did not contribute to yield gap in potato.

iii) Progressive farmers

The results of the yield gap function for progressive farmers is presented in Table XXVII and the estimated function is presented below.

$$\hat{Y} = 618.82 + \underset{(4.687)}{13.253}\, X_1^{*} + \underset{(5.882)}{10.112}\, X_2 + \underset{(0.8263)}{0.7827}\, X_3 + \underset{(4.842)}{14.412}\, X_4^{**}$$

$$+ \underset{(327.9)}{891.59}\, X_5^{*} - \underset{(1.3142)}{0.6896}\, X_6$$

$R^2 = 0.60$ $\hat{R}^2 = 0.4589$ $n = 17$

** Significant at 1 per cent level

* Significant at 5 per cent level

TABLE XXVII

ESTIMATED REGRESSION COEFFICIENTS OF YIELD GAP FUNCTION

(PROGRESSIVE FARMERS)

S.No.	Variable	Regression co-efficient	't' statistic
1.	Intercept	618.82	-
2.	Seed rate (kg/ha)	13.253	2.827*
3.	Number of irrigation	10.112	1.719
4.	Farm yard manure (kg/ha)	0.7827	0.947
5.	Potato mixture (kg/ha)	14.412	2.976**
6.	Plant protection chemicals (kg/ha)	891.59	2.719*
7.	Education (Number of years of schooling)	-0.6896	-0.5247

R^2 = 0.60
F = 0.4251

Note : ** Significant at 1 per cent level
* Significant at 5 per cent level

The co-efficient of multiple determination (R^2) was 0.60 indicating that 60.0 per cent of the variation in yield gap could be explained by the independent variables included in the yield gap function.

The co-efficient of seed rate was 13.253 and significant at five per cent level. It implied that an increase of seed by one kg would reduce the yield gap by 13.253 kg.

The co-efficient of potato mixture was 14.412 and significant at one per cent level. It implied that an increase of one kg of potato mixture would bring down the yield gap by 14.412 kg.

The co-efficient of plant protection chemicals was 2.719 and significant at five per cent level. It implied that an increase of one kg of plant protection chemical would reduce the yield gap by 2.719 kg/ha.

The variables number of irrigations, farmyard manure and educational status were non singnificant and did not have any influence on yield gap.

It could be concluded that potato mixture, plant protection chemicals, farmyard manure and seed rate were the major determinants of yield gap in the study region.

SUMMARY AND CONCLUSION

CHAPTER VI

SUMMARY AND CONCLUSION

Green Revolution has brought agricultural production to a perceptible level particularly in foodgrain production. However, agricultural production per unit area tends to level off with the cost of inputs becoming prohibitive. Skilled labour, high input cost, vagaries of nature and marketing difficulties are rendering agriculture as an unremunerative enterprise. According to the National Commission on Agriculture, India has to produce 240 million tonnes of foodgrains by the turn of this century. This situation calls for concerted efforts to increase the production quantitatively and qualitatively in a short span of five years. In this regard, tuber crops form the next best alternative to cereals. Further, as satisfactory levels have already been reached with regard to production of rice and wheat, the deficiency has to be compensated by crops other than cereals. Tropical tuber crops which have a great role to play in this task should be given a proper place in agricultural planning.

Among the major tuber crops, the larger share comes from potato, both in area and production, followed by cassava and sweet potato. While the productivity of potato is about 15 t/ha and is on par with world average still there exists scope for augmenting the productivity. The high rate of increase in area, production and yield of potato in India in the four decades after Independence is a testomonial to the ever increasing popularity of this crop which is used mostly as a vegetable and available throughout the year in all parts of the country. In spite of all this, the per capita availability of potato in India is only one third of that of the world. Further, there existed variation in area, production and productivity in the different agro-climatic regions of the country. As regards Tamil Nadu, though it ranked first in the productivity, its performance in area and production is of great concern to the development authorities and policy makers. Besides, there existed wide inter and intra regional variations in the productivity. So there is need for studying the trend in area, production and productivity of potato, the yield gap and constraints in potato production to formulate appropriate policy package for development of potato. The present study is an attempt to find out the reasons for declining area under potato in the Nilgiris district, the most pronounced potato growing tract of Tamil Nadu and ways to bridge the yield gap.

The overall objective is to study the trend in area, production and productivity of potato in the Nilgiris district and delineate the determinants of yield gap among the ordinary potato growers and progressive farmers. The specific objectives of the study are (i) to analyse the trend in area, production and productivity of potato in the Nilgiris district (ii) to study the fluctuations in area under potato at farmers level and to isolate the factor (s) for the same, and (iii) to study the yield gap of potato and constraints associated with it.

The present study was carried out in Udhagamandalam taluk of the Nilgiris district, since the decline in potato area was more pronounced in this taluk as compared to the other three remaining taluks of the district. Of the twenty villages in the taluk, six villages having the largest area under potato and at the same time exhibiting declining trend were selected. In each village, fifteen potato growers were selected at random. Besides, five progressive farmers were selected at random from each of the six villages, constituting a total number of thirty progressive farmers. In all, 120 farmers were contacted for the study. In order to study the yield gap and difference in technology adoption among the farmers and research stations, data on field experiments conducted at the University research station at Vijayanagaram was also collected. For carrying out a comparative analysis, the respondents were post-stratified into farmers possessing a size of farm less than two hectares and those possessing more than two hectares and progressive farmers, since marked differences were observed between them.

The findings of the study are summarised in what follows.

1. Growth model :

To evaluate the temporal movement in area, yield and production of potato in the Nilgiris district, Gompertz growth model was used. During the pre-green revolution period from 1955-56 to 1969-70, growth rate of area was -0.4858 per cent and in the post-green revolution period from 1970-71 to 1992-'93, it was -0.1426 per cent. The overall trend showed a decline in area under potato over years (-0.2498 per cent). Growth rate for production and productivity showed a positive trend of 1.29 per cent and 1.71 per cent respectively.

2. Basic characteristics of the sample households

2.1. The distribution of small farmers among sample respondents varied from 1.82 per cent in Nanjanad village to 27.27 per cent in Hullathi and Kagguchi villages. Similarly, the distribution of large farmers ranged from 17.14 per cent in Ithalar village to 40.00 per cent in Nanjanad village. The progressive farmers constituted 16.67 per cent in each of the six villages since a fixed sample of five progressive farmers were alone chosen in each chosen village.

2.2. The total extent of the sample farms was 134.9 hectares. Nearly 42 per cent of the total area was accounted for by small farmers and the remaining by large farmers. The average size of small farms and large farms worked out to 1.04 and 2.22 hectares respectively while the same for the progressive farmers was 2.43 hectares.

2.3. Nearly 38.00 per cent of the small farmers were educated upto higher secondary level of education. The remaining 36.36 per cent were educated upto high school, 23.64 per cent upto collegiate level and 1.81 per cent upto middle school level of education. Nearly 60.00 per cent of the large farmers were educated upto collegiate level. Among the progressive farmers nearly 80 per cent of the respondents studied beyond high school level. None of the sample respondents were illiterates.

2.4. Land was the most important asset held by the respondents accounting for more than 50 per cent of the total asset. While for the small and large farmers, land constituted 49.47 per cent of the total asset, it was 55.00 per cent for progressive farmers. Buildings constituted 31.85 per cent of the total asset for small farmers while for large farmers and progressive farmers it was 42.62 and 33.41 per cent respectively. Deadstock accounted for 6.18 per cent of the total asset of sample respondents and it was 7.26 per cent for the progressive farmers. Livestock shared only 3-6 per cent of the asset held by the farmers in the study area.

2.5. The net area sown per farm was highest among the progressive farmers with 2.43 hectares, followed by large farmers with 2.22 hectares and small farmers with 1.04 hectares. The area sown more than once was 1.56 hectares per farm for progressive farmers as compared to 0.75 hectares for the sample potato growers. The cropping intensity was 180.76, 126.58 and 164.19 per cent for small, large and progressive farmers respectively.

2.6. The major crops cultivated in the study area were potato, cabbage, tea and carrot. Potato was cultivated in 28 per cent of the gross cropped area of the ordinary potato growers followed by cabbage, tea and carrot in 25.45, 25.00 and 12.50 per cent of the gross cropped area respectively. Among the progressive farmers, 28.82, 25.06, 22.81 and 14.29 per cent of the gross cropped area was occupied by potato, cabbage, tea and carrot respectively.

2.7. The only source of irrigation in the study area was wells. The well irrigated area per farm for the entire study region was 0.75 hectare accounting for 50.34 per cent of the total extent of the farm. Among the progressive farmers, well irrigated area was 1.28 hectares and it accounted for 52.67 per cent of the total extent of the farm. The irrigation intensity for small, large and progressive farmers was 100 per cent only.

2.8. The cropping pattern followed in the study region in general was potato-cabbage-carrot/beetroot. This cropping pattern is being followed by 20.00 and 25.71 per cent of the small and large farmers respectively for more than ten years. On the contrary, 30 per cent of the chosen progressive farmers have followed the aforesaid cropping pattern for more than ten years. In all, 92 per cent of the ordinary potato growers and 76.67 per cent of the progressive farmers have followed this cropping pattern for more than five years.

2.9. The decline in area under potato for the sample respondents for the entire study region was 57.76 per cent and it varied from 57.59 per cent in the case of small farmers to 58.17 per cent in the case of large farmers. The percentage decline in area under potato for sample progressive farmers was 45.73.

2.10. All the respondents in the study area attributed high cost of cultivation as the major reason with a mean score of 61.62 for shift to other crops from potato. The next important reason given by small and large farmers was fluctuating prices, the mean score being 41.86 and 41.87 respectively. Progressive farmers, however, stated that lack of storage and marketing facilities was the second reason for shift to potato with a mean score of 47.0.

2.11. The main reason attributed by the small and large farmers for choice of the variety, Cufri Jyothi was that it is the only available variety. The progressive farmers gave a mean score of 55.87 for choice of this variety for the reason that it is a high yielder.

3. Yield gap

3.1. There existed considerable yield gap in potato and yield gap I was greater than yield gap II. Yield gap I was highest among small farmers (45,500 kg/ha) followed by large farmers (41,800 kg/ha). The yield gap I was lowest for progressive farmers (31,300 kg/ha). In terms of percentage, yield gap I was 63.37, 58.22 and 43.59 for small, large and progressive farmers respectively. Yield gap II was 14,431.82 kg/ha for small farmers followed by 8442.86 kg/ha for large farmers and was the lowest for progressive farmers (8383.33 kg/ha). In percentage terms, it was 54.78, 28.14 and 20.69 for small, large and progressive farmers respectively.

4. Constraints

4.1. Lack of suitable varieties exhibiting resistance to nematode and at the same time having good quality was the major technical constraint expressed by the small and large farmers, followed by pest and diseases problem with a mean score of 50.42 and lastly water problem in the first season with a mean score of 46.0. Progressive farmers however, indicated water problem in the first season as the major constraint with a score of 58.88 followed by pest and diseases and lack of suitable varieties.

4.2. High cost of inputs, poor quality of inputs and lack of owned funds for carrying out timely operation were the major socio-economic constraints confronted by the potato growers. Among the progressive farmers, high cost of inputs, poor quality inputs, unfavourable marketing facilities, lack of storage facilities and non-availability of inputs in time were the major constraints.

5. Functional analysis

The relationship between yield gap and the applied inputs was studied by fitting linear regression equation for the different categories of farmers.

5.1. The co-efficient of multiple determination was 0.358 for small farmers, 0.4031 for large farmers and 0.60 for progressive farmers, indicating that the variation in yield gap for the above three farmer categories could be explained by the variables included to the extent of 35.8 per cent, 40.31 per cent and 60.0 per cent respectively.

5.2. In the case of small farmers, the co-efficients of potato mixture and plant protection chemicals (9.9697 and 865.14 respectively) were found to be significant indicating the possibility of narrowing the yield gap by increasing the use of the above inputs.

5.3. In the case of large farmers, the co-efficients of farmyard manure and potato mixture were significant. This clearly indicated that by increasing the above inputs by one kg per hectare *ceteris paribus*, the yield gap could be reduced by 1.3746 and 4.4761 kgs for farmyard manure and potato mixture respectively.

5.4. In the case of progressive farmers, the co-efficients of seed rate, potato mixture and plant protection chemicals were 13.253, 14.412 and 891.59 respectively and were found to be significant. To get higher yields, the progressive farmers have to increase application of these inputs.

CONCLUSION

The study thus clearly indicates that there is vast scope to increase the yield of potato with the available technology. Though the area under potato cannot be increased, production and productivity can be increased. Crops like potato which produce much energy and protein per unit time should be popularized. If the crop is to expand, farmers must be willing to grow it and must consider risks, profitability, cash flow and suitability of the crop for their farming pattern and home consumption. In general, potato meets their needs except for high risks associated with production and marketing and as such future expansion very much depends upon reducing the production cost of potato relative to other crops.

The scope for reducing production cost per hectare are limited to breeding varieties and improving seed production programme, but the cost of chemical fertilizers and pesticides nullify this reduction. Fertilizer is a costly input and its judicious use is imperative to increase the yield and reduce cost of production. An integrated nutrient management approach including the use of bio-fertilizer, organic manures and wastes as complementary source of fertilizer is of paramount importance to achieve best results at low cost.

POLICY OPTIONS

1. The yield gap analysis revealed that the differences in the potato yield between the research stations and the progressive farmers in general ranged betwen 31,300 kg/ha to 59,300 kg/ha, between the research station and the large farmers and that of small farmers ranged between 41,800 kg/ha and 56,800 kg/ha and 45,550 kg/ha and 46,800 kg/ha respectively. This clearly indicates the magnitude of the untapped yield potential under the existing technology and resource situations. Hence there is an urgent need for proper identification of technical and socio-economic constraints and formulation of appropriate policy packages to remove the existing production constraints.
2. Irrespective of the categories of farmers, the yield gap II could be bridged if farmers are motivated to take some additional efforts in adopting the recommended technologies.

Timely supply of adequate quantity of inputs at reasonable rates, economic prices for potato and training of farmers to impart skill necessary to understand and use the new technology are some of the incentives for increased potato production.

3. The major technical constraint for majority of the potato growers was lack of suitable varieties. Research on potato has to be centred around developing a high yielding cultivar with resistance to nematodes and at the same time maintaining acceptable quality. Hence scientific seed programme has to be taken up.

4. The next major constraint was pest and diseases problem which could be removed by educating the farmers on need based plant protection measures for which special extension efforts have to be taken up.

5. The important socio-economic constraints in potato cultivation were high cost of inputs, poor quality of inputs and lack of owned funds. In this regard, an organisation of root and tuber crops would do well to emulate the example of milk producers co-operative operating at the different parts of the study region. There is also a need for rationalisation of provision of agricultural credit through credit institutions. Besides, the government should have a realistic policy so that the credit sector will be viable and continue to help the farmers for increasing the production in the long run.

6. Provision of remunerative price is important for increasing the productivity. Majority of the farmers suggested that

procurement prices can be fixed for this tuber crop also in line with the procurement price of cereal crops.

7. Since there existed instability in the rainfall, concerted efforts must be taken up for afforestation which would pave way for adequate rainfall. Besides, the felling of trees in the name of urbanisation and construction of factories should be banned.

8. The conversion of cultivable lands for construction of buildings is also one of the reasons for the decline in the area under potato. Therefore, due attention must be given for arresting such conversion of lands into non-agricultural uses.

In sum, there should be a comprehensive policy of production in the entire district to arrest the decline in the area under potato and to bridge the yield gap keeping in view of the short term and long term benefits of the farming community of this tract.

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