SOME OBSERVATIONS ON THE USE OF WIND ENERGY IN SRI LANKA

by

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ARTICLE NO. 2

Abstract

Recent investigations have revealed that windpumps have been a great asset to the rural farmer and especially so during the recent drought. Many farmers had lost three consecutive crops and several districts received drought relief. In this situation it was wonderful to see a creative and contented farmer using a windpump and having a plot of green, bearing a food crop in the midst of a parched desert like environment. Windpumps have also been used for maintaining livestock, in water supply for domestic consumption and tropical fishbreeding while wind turbines have been used for battery charging at village level and for small scale rural electrification. The overall lack of sufficient commitment of policy makers at a national level in harnessing this resource is a matter for regret. Wind energy can be of great benefit to the nation and a thorough investigation of the wind energy potential of Sri Lanka and its possible uses is warranted.

1. Introduction

Energy is indispensable to society. As stated by E.F. Schumacher 'there is no substitute for energy, the whole edifice of modern life is built upon it'. (Kirk 1983).

While the world is consuming energy at an ever increasing pace, the presently known reserves of oil, coal and natural gas are being continually exhausted. About 90% of the global energy requirement is met by these three sources taken from nature's reserve, without the possibility of renewal. Water power which is a renewable resource, makes a contribution of about 6% towards the global energy requirement (energy statistics for 1984 from 'World Resources' - 1986).

In 1973 the price of oil increased sharply and caused much hardship to vast sections of the global population and in particular had adverse effects on the economic of many developing nations like Sri Lanka.

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These factors have given rise to a large scale interest in the use of renewable energy resources such as wind, wave and solar power. Accordingly, several countries from the developed world and from the third world have embarked upon programs to harness wind energy. Among these are the U.S.A., Denmark, Britain, India, China, Thailand and certain nations from the Arab world and Africa.

2. Present Global Situation

It is most encouraging to note that there are multi-megawatt capacity wind turbines installed or under further development in countries like the U.S.A., (2.5 MW - Boeing Mod 2;4.0 MW - WTS4), Germany and U.K. These machines with a modern micro-processor controller showed that wind turbines could be operated completely unattended. In California, where the average wind speed in the coastal region is in the region of 7.0 m/s there are wind farms and since 1981 more than 8000 wind turbines have been installed with a total capacity exceeding 600 MW. (Musgrove '87). Presently studies are underway in the U.K. and certain European Countries on offshore wind energy conversion systems.

The 7.5 MW wind farm along the IJsselmeer dike north of the Urk village in the Netherlands is presently the largest among many windfarm projects in Europe. It consists of 25 windturbines with a rated output of 300 KW each. At Urk the yearly average wind velocity is 6.0 m/s at a height of 10m. (Special Wind Power Europe '87 - Oct. '87).

In remote locations with low power requirements and a higher cost per unit for electricity delivery, wind battery storage has been found to be attractive. A number of manufacturers in Europe and North America now offer small wind turbines (10KW - 100KW) designed for application in remote areas for irrigation, desalination, icemaking, telecommunication, village household lighting, radio and television sets and microwave repeaters etc. (Musgrove '87).

China's Ministry of Water Resources and Electrical Power has recently ratified its next five year plan for the 1986 - 90 period in which wind energy features significantly. They plan a general survey of China's wind energy potential, a programme to popularise the technology, improvements to establish wind turbine testing facilities and improve wind turbine manufacturing techniques (Wind Power Monthly June 1986).

For waterpumping on a smaller scale the multi-bladed windmill is still appropriate. Many tens of thousands of these are being used worldwide. Countries such as India, Kenya and Thailand have found that for rural applications like water pumping, the most appropriate alternative among several choices available is the wind pump. In Thailand wind pumps are used in the saltern farms to reduce the petroleum cost and this has demonstrated the cost effectiveness of wind pumps in some large projects. (Koetsinchai & Suwantragul 1986).

The present state of wind energy technology encourages developing countries to harness wind energy as an economical alternative energy source.

3. Use of Wind Energy - Local Situation

One cannot forget at the very

outset the enormous creativity and skill of our own fishermen at harnessing wind energy using the traditional sailcloth-boat technology. Today this state-of-the-art is fast vanishing while the pros and cons of some types of modern technology and their social and environmental implications can always be questioned.

The Water Resources Board embarked on a program to use wind energy by establishing the wind energy unit in the year 1978. During the period 1978-87 about 200 windpumps were installed for use in agriculture. At present it is estimated that there are about 40 locations around the Anuradhapura region that use windpumps.

Field investigations done in Aug '87 at several such locations revealed that these have been functioning well and have been very useful to farmers growing a variety of subsidiary food crops like chillies, brinjals, bitter-gourd etc. in ½ - 2 acre lots, while some have been considerably larger in extent. These windpumps have been nothing short of a blessing to the small rural farmer during the period of prolonged drought the country experienced. Wherever groundwater was available adequately, the windpumps have fulfilled their task. Farmers in many parts of the Country had lost three consecutive crops and many districts received drought relief. In this situation it was indeed wonderful to see a creative and contented farmer using a wind pump and having a plot of green, bearing a food crop in the midst of a parched desert like environment. Relatively unknown, every rural farmer quietly sustains the life on the nation.

There have been a variety of other uses of windpumps. These have been in animal husbandry, small scale water supply for domestic consumption, maintaining a large aquarim (freshwater tropical fish breeding for export) and in successful intercropping of a variety of crops like pepper, passion fruit, pineapple, beetroot, banana etc. (Dikkelle Estate, Pannala; Sarvodaya farm, Anurdhapura).

Wind turbines have been used by some for battery charging at village level (Pitipana - Project of Industrial Development Board - Appropriate Technology Centre, Pannala) and on a somewhat larger scale for rural electrification as at Pattiyapola (near Tangalle), in association with the Rural Energy Centre of the Ceylon Electricity Board. The use of wind turbines have been more on an experimental basis and needs a lot more thought and development for commercial use.

It is tragic to note that a simple technology which can be operated and maintained at village level and has proved to be so useful to the rural farmers and many others had to be abandoned by the Water Resources Board at the beginning of 1987. Some of the questions that arise out of this issue are :

a) Why did this program have to be completely abandoned and was this done after thorough investigation ?

b) If one of the reasons was that of economic viability what were some of the corrective measures that could have been adopted? Was it necessary to totally abandon this program rather than transfer it to another appropriate institution such as the Energy Unit within

the Ceylon Electricity Board or any other organisation ?

c) What is the alternative offered to the farmer ?

d) What are the long-term consequences of such a decision ?

Some have expressed the view that the ethnic disturbances in the country also affected the sale of the windpumps to the northern regions where there was a good demand. What is worth questioning is whether in such a situation windpumps for small scale agriculture would not have been an excellent alternative to engine pumps which are dependant entirely on the availability of fuel at a reasonable price.

At a time when even the richest nations in the developed world are endeavouring to harness this resource to its fullest, the irony seems to be that Sri Lanka which has been blessed with this resource wishes to throw it away. The technology is available, can we solve the economic problem ?

4. Meteorological Factors and Topography

The main requirement for wind energy utilization is an appropriate average wind velocity lasting over a reasonable duration during the year. The wind velocity at a location shows a seasonal fluctuation. Wind velocities in the region of 3-10 m/s offer the greatest potential at present. Wind velocities less than about 2.5 m/s have been found to be rather inadequate while velocities in excess of 10 m/s can be structurally destructive.

Some of the other factors that need consideration in site selection are wind shear, wind turbulence and wind acceleration. Wind shear causes the slowing down of wind near the ground. Hence, the surface roughness of the site is an important factor to be considered. Flat, low grass sites are more favourable than town centres.

Wind turbulence has the adverse effect of reducing the power output of the wind machines. The flow over buildings, trees and ridges etc. causes rapid changes in wind speed and direction. Therefore when selecting a site, care should be taken to minimize the effect of wind turbulence.

Wind acceleration over hilltopa increases the wind speed, making it a potentially good site. The ridge should be smooth and neither too steep nor too flat. The ideal angle is about 16°, but angles between 6°-16° are satisfactory and angles greater than 27° should be avoided (Lysen 1982).

5. Wind Pattern in Sri Lanka

The uneven heating of the earth leads to a complex large scale circulation of air, causing winds. During most of the year the tropics receive appreciably more solar energy per unit area of the earth's surface than the polar regions. Sri Lanka which is located between 5°-10°N of the equator has a favourable quantum of wind energy.

Table 1 shows the distribution of average wind velocities over Sri Lanka on a monthly basis. According to these figures the highest wind velocities are prevalent in the Southern and Northern coastal regions. A closer inspection shows that even vast section of the dry zone too have high wind velocities during the Yala season (May-Sept/Oct). Farmers who have installed wind pumps are well aware of this natural phenomenon and have made ample use of this resource to grow

subsidiary food crops. Observe in fig. 1 how the wind velocities increase while the monthly rainfall decreases during this season. Even during normal years, farmers who use wind pumps are better assured of a water supply than others who are entirely dependant on rainfall with its associated uncertainities.

6. Results of some field experiments 20 - 22nd - August 1987

LOCATION

	(1) Mihintale, Kannattiya	(2) Nelun Kulama Farm Anuradhapura (Sarvodaya)	(3) Horowpathana
Type of wind pump	WEU 1 developed by the Water Resources Board		
Cost of machine at present	Rs. 16,000 - 17,000		
Annual operation & maintenance cost (Rs)	300.00	300.00	300.00
Suction Head (m)	7.50	7.0	7.0
Delivery Head (m)	1.5	1.5	2.0
Av. wind velocity (m/s)	7.0 m/s	***	***
Av. discharge m^3/hr	2.8 (616 gals/hr.)	***	***
Types of crops	Chillies (1Ac), Brinjals (½Ac) Bitter-gourd (½Ac)	Inter-cropping under banana with Beetroot (½Ac), Snake-gourd (½Ac) Tomato ½, Carrot ½	Onions (½Ac) Chillies (½Ac) Cowpea (½Ac) Gingelly (½Ac) Other crops (½Ac)
Extend of Land	2 Acs	1 Acs	1½ Acs

*** Detailed observations were not made at these locations

It was observed from field experiments done in Mihintale; at Pannala (Dikelle Estate) and at Ratmalana, that the WEU1 windpump is capable of giving an average discharge of about 1.5m³/hr (330 gals/hr) under an av. wind speed of 4 m/s with a lift (suction + delivery) of 9.0 m. The instantaneous wind speed was recorded at 15 sec. intervals using an anemometer and the total discharge was observed at 10 min. intervals using a flow meter. Many of the windpumps in the Anuradhapura region were discharging from wells where the water levels were about 7.5 m below ground level. Experiments done by the designers of this machine to assess the overall daily performance, estimate an output of 10,000-12,000 gallons/day at a typical wind speed of 4 m/s and a head of about 9m.

7. Conclusions

1) The present global situation clearly reveals that there is tremendous interest in utilizing wind energy in the advanced countries as well as in the developing countries.

2) Sri Lanka has been abundantly blessed with this resource. Wind velocities in the region 3.00 - 10 m/s offer the greatest potential at present. The southern coastal region, the northern area and also vast sections of the dry zone (seasonally) are most promising for wind energy utilisation. Field experiments have confirmed the great asset wind pumps have been to the rural farmer in growing subsidiary food crops. It was observed that farmers who have installed wind pumps are better assured of a water supply during the dry season (Yala) than those who are totally dependant on rainfall with its associated uncertainities. During this season, while there is a decrease in rainfall there is a corresponding increase in wind velocities suitable for the operation of wind pumps. In addition, wind machines have been used for small scale domestic water supply, animal husbandry, maintaining a large aquarium, battery charging at village level and for rural electrification.

3) The saltern at Hambantota could be a most promising site for several wind pumps and this will reduce the operational cost of engine pumps.

4) It is most unfortunate that the wind energy program of the Water Resources Board had to be totally abandoned without making alternate arrangements for an appropriate authority to continue the work which had begun to show very fruitful results. Considering the meteorological factors, the technological aspects (satisfactory design with only minor improvements needed and village level operation & maintenance possible, except in cases of major structural failure) and the opinions of the users themselves, it does not seem at all justifiable to drop this whole program completely. Credit facilities were available to farmers through some state banks. Strengthening such facilities will be most helpful and essential for the farmers, since the cost of a windpump is about Rs.16,000-17,000/= at present. This seems fairly large and a more cost efficient design would certainly be helpful. To the knowledge of the authors there is one private enterpreneur now

manufacturing these windpumps in a very small factory near Jaffna junction - Anuradhapura. There is a need to revive this program at a national level perhaps with a different mode of implementation and better credit facilities available through the rural banking sector.

5) The operation and maintenance of wind pumps can be done very satisfactorily at the village level. It has been shown that wind pumps are also more economical than kerosene pumps, the cost per cubic metre of water delivered by a wind pump being 70% of that by an engine pump (Fernando '87). Some improvements need to be done on the windpumps about the problem of leather washers wearing out rather rapidly after sometime. The cost is minimal and replacement is quite simple and done by the users themselves. Perhaps the actual problem could be associated to some degree with the matter of machine alignment. Some improvements to the locking mechanism will also be desirable.

6) The results of experimental work of the Rural Energy Centre at Pattiyapola which has been carried out over a considerable period of time need to be tranferred much more to the rural communities. This matter needs serious attention. The work of the energy unit should be strengthened and expanded even to explore in depth the possibilities of wave energy utilisation. It has been estimated that the wave power along the southern coast of Sri Lanka is in the order of 40 kw/m. If one could harness 10% of this amount over a 150 km distance, it would amount to a sizeable 600 MW (De Zoysa 1987). Wave energy utilization as a possible alternative method of arresting the serious problem of coastal erosion has also been strongly recommended and some potential sites where suitable experimental work may be done have been suggested by Wickramasuriya (1987).

7) Recent research has shown that under certain conditions solar water pumps are more feasible than diesel pumps or wind pumps (Kenna and Gillet '85). Further work on the use of solar water pumps in Sri Lanka will be most useful. Research institutes and relevant organisations should embark on a solid program to carry out research and development into the use of renewable energy resources such wind, wave, solar, biomass and small scale hydro in Sri Lanka.

8) When one sees a world around us, comprising both developed as well as developing nations attempting to harness wind energy, a free gift to mankind, one cannot help but express surprise and considerable frustration, observing Sri Lanka which has been bestowed with this resource turning its back on this natural gift. Wind energy can be of great benefit to the nation and a much more thorough investigation of the wind energy potential of Sri Lanka and its possible uses is warranted.

8. Acknowledgement

This research project is funded by the University of Moratuwa.

The authors wish to thank Mr. K.S. Fernando; the staff of the Energy Unit of the Ceylon Electricity Board and at the Rural Energy Centre at Pattiyapola; Appropriate Technology Centre - Pannala and the Department of Meteorology for supplying the relevant meteorological data.

9. References

1. Fernando K.S. (1987)- Global Wind Pump Evaluation Program, Country Study on Sri Lanka, Consultancy Services Wind Energy Developing Countries, Netherlands.
2. De Zoysa A. (1987)-Energy Sources for Sri Lanka - SLAAS Seminar 30th April '87.
3. Fraenkel P. (1986) - Water Pumping Devices; A Handbook for Users and Choosers, Intermediate Technology Publications.
4. Lancashire S. (1987) Windpumping Handbook, Intermediate Technology Publications.
5. Kenna J. and Gillett B. (1985) - Solar Water Pumping; A Handbook, Intermediate Technology Publications.
6. Kirk G. (1983) Schumacher on Energy, Abacus.
7. Koetsinchai W. and Suwantragul S. - Regional Seminar on Alternative Energy Applications in Agriculture, Chiang Mai, Oct, 1986.
8. Lipman N.H., Musgrove P.J., and Pontin G.W. (eds) (1982) - Wind Energy for the Eighties, Peter Peregrinus.
9. Lysen E.H. (1982) Introduction to Wind Energy, Steering Committee Wind Energy Developing Countries. (SWD 82-1) The Netherlands.
10. Mann R.D. (1979) - How to build a Cretan Sail Wind Pump, Intermediate Technology Publications.
11. Meteorological Aspects of the Utilisation of Wind as an Energy Source (1981) WMO Technical Note 175, Geneva, Switzerland.
12. Musgrove P.J. (1987) - Wind Energy Conversion: Recent Progress and Future Prospects, Solar and Wind Technology Vol. 4 No. 1.
13. Ramage J. (1983) - Energy: A guidebook, Oxford University Press.
14. Special windpower Europe (1987) Duurzame Energies, Oct, '87.
15. Taylor R.H. (1983) Alternative Energy Sources for the Centralised Generation of Electricity, Adam Hilger.
16. Wickramasuriya A.T.G.A. (1987) - Prospects for Harnessing Wave Energy and Marine Resources of Sri Lanka, Transactions Vol. I, The Institution of Engineers, Sri Lanka.
17. Wind Power Monthly (1986) June.
18. World Resources 1986 - World Resources Institute & International Institute for Environmental and Development, Basic Books Inc; New York.

Windmill for Water Pumping

- Rural Energy Centre

Pattiyapola

Tangalle

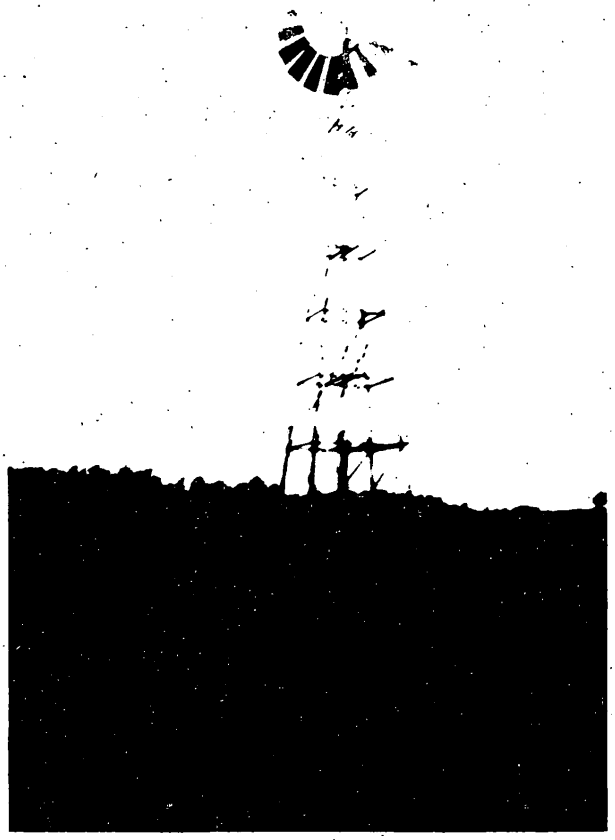

TABLE 1

Average monthly wind speed (m/s) in different areas

(Department of Meteorology - Climatological Data Sheets)

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anuradapura	1.7	1.8	1.6	1.4	2.9	3.8	3.5	3.5	3.3	2.1	1.3	1.6
Batticaloa	4.0	3.6	3.0	2.6	2.6	2.6	2.7	2.7	2.7	2.6	2.9	3.6
Colombo	2.5	2.1	1.9	2.1	2.8	3.0	2.8	2.9	2.8	2.5	1.9	2.4
Hambantota	6.0	5.6	4.6	4.2	6.1	6.4	6.4	6.6	6.5	5.3	4.0	4.9
Jaffna	2.0	2.1	2.6	4.1	6.7	7.4	6.6	6.4	6.4	4.2	2.3	2.1
Kankasanthurai	4.3	3.6	2.8	2.7	4.6	5.2	4.5	4.3	4.3	3.2	3.5	4.6
Mannar	4.2	3.6	3.0	3.1	4.3	4.8	4.5	4.5	4.5	3.3	3.1	4.0
Mahailluppallama	2.0	2.0	1.8	1.6	3.4	4.6	4.4	4.4	4.2	2.5	1.5	1.8
Puttalam	2.5	2.4	2.3	2.5	4.0	5.1	4.8	4.7	4.6	3.1	2.0	2.4
Trincomalee	5.2	4.0	2.9	2.9	4.6	6.1	5.5	5.1	4.6	3.7	3.8	5.1

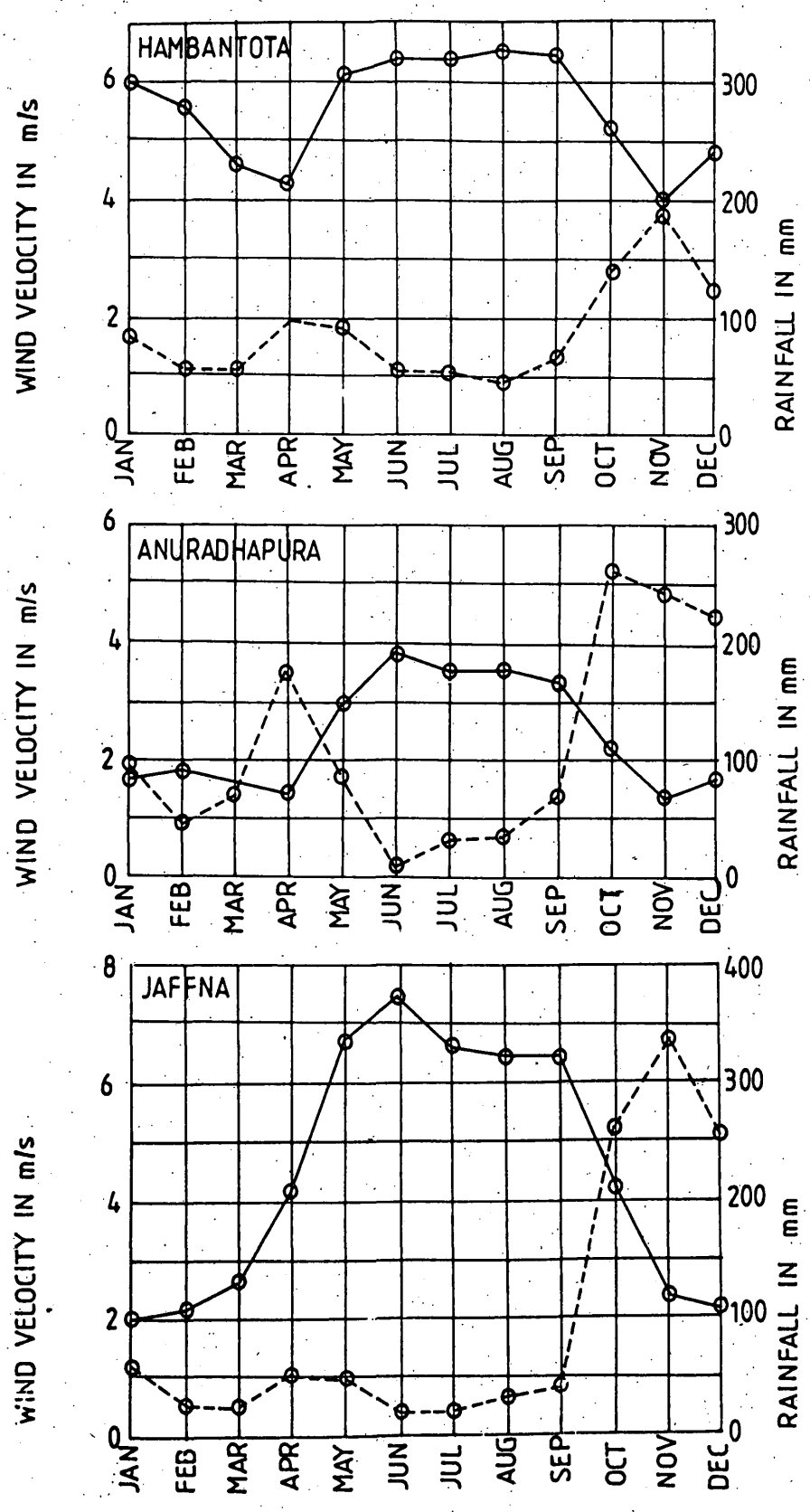

FIG. 1 Average Monthly Wind Velocity & Rainfall