911 91 - 5/105

Agroecology
Review, book, case studies, developing countries, environment, women, food, water management, forests, fuel, energy, human settlements, environmental conservation, training, planning, woman organizations, international cooperation, NGO's

DANKELMAN, I. and J. DAVIDSON

Women and environment in the Third World.

Earthscan Publications Ltd., London in association with the Int. Union for Conservation of Nature; ISBN 1-85383-003-8, 1989, 203 p. + index

Women, particularly those living in the rural areas of Third World countries, play a major role in managing natural resources - soil, water, forests and energy. Their tasks in agricultural and animal husbandry as well as in the household make them the daily managers of the living environment. They have a profound knowledge of the plants, animals and ecological processes around them.
Women also participate in the commercial sectors of society and the raw materials they use in rural enterprises are vulnerable to environmental degradation and contamination. As farmers and traders, then, women experience environmental problems as directly undermining the basis of their daily lives.
The principal victims of environmental degradation are the most underprivileged people, and the majority of these are women. Their problems, and those of the environment, are very much interrelated. Both are marginalized by existing development policies. And because of the complex cycles of poverty, inappropriate development and environmental degradation, poor people have been forced into ways of living which induce further destruction. Third World women often have no choice but to exploit natural resources in order to survive, even though they may have the knowledge to promote sustainability.
The project on which this book is based was financed by the Netherlands Ministry of Foreign Affairs and carried out under the auspices of the Netherlands IUCN Committee. The aim of the volume is threefold: first, to examine the relationships between women and their natural surroundings; secondly, to show how women deal with the environmental crises they face; and thirdly, to look at the response of international and government agencies.
The first part of the book explores women's involvement in the use and water management of natural resources, their role in agriculture, water supply, forestry, the collection and use of fuelwood and the development of other energy sources. The special problems women face in human settlements are also discussed here. Examples and case studies illustrate the effects of environmental degradation on women and the initiatives they take.
In the second part of the book, the position of women in environmental conservation is examined, with an emphasis upon their practical activities and their role in education and

training, family planning and local organizations. The activities and policies of international agencies are described and a final chapter sums up the picture and presents a strategy for action.
This book builds upon efforts and advances the argument for listening to what women have to say. It describes not only how women become the victims of environmental crisis, but how they are responding. All over the world, women are taking action against the destruction of natural resources on which their lives depend.
Important, in practical terms, has been the growth of environmental action by women's groups around the world. The Chipko movement in India and Kenya's Green Belt Movement are just two examples of many new initiatives designed to help women tackle the problems of environmental devastation. Many of them are described in this book.
The authors provide a clear account of the problems faced by women in the management of land, water, forests, energy and human settlements. They also describe the lack of response from international organizations. With the help of well-documented case studies they describe the ways in which women can organize to meet environmental, social and economic challenge.

912 91 - 5/106

Agroecology
Review, paper, environmental management, environmental monitoring, data collection, utility of data, global data base, organizational aspects, forecasting, policy development, aid allocation, project evaluation, UNEP

CLARKE, R.

GRID: a tool for environmental management.

In: The Handbook of Ecological Monitoring; a GEMS/UNEP Publication; Clarendon Press, Oxford, 1986, pp. 283-289

Ecological monitoring, of the kind described in this paper, is only one way of gathering environmental data. Most countries regularly monitor several environmental variables, particularly those relating to climate. National surveys of geology, land-form, and soil type are continually being improved. National maps of vegetation and forest cover exist in all developed countries, and in many developing ones.
Census data also exist almost everywhere. Most countries have reasonably reliable data on the geographical distribution of crops, livestock, and wildlife, size, and location of smallholdings and farms, and incomes and employment of local populations.
Similar information is also gathered and stored on a regional and global basis. The World Meteorological Organization, for example, monitors and publishes global meteorological data; Unesco has published a series of global Vegetation Maps; and FAO has produced a Map of World Soils.
The Global Environment Monitoring System (GEMS) of UNEP plays an important role in co-ordinating and promoting global monitoring in five major areas: climate, the long-range transport of pollutants, health-related monitoring, ocean monitoring and monitoring of renewable resources. As a result, knowledge of such important environmental phenomena as atmospheric pollution, the world climatic system, the build-up of carbon dioxide in the atmosphere, acid rain, water quality, deforestation, and the state of the world's soils is continually being improved. Large quantities of data are collected every year, and stored in data banks. Some are published in map or tabular form, and some are used to make major assessments of the state of the world environment.
The need for a data base which incorporates different environmental data sets - for example, on soils, forests, vegetation, land-use, climate, pollution, and socio-economic variables - was foreseen by GEMS several years ago.
The project is known as the Global Resource Information Database (GRID). Its pilot phase begun in March 1985. By that time, GRID had received substantial backing both nationally and internationally.
When fully operational, GRID will provide decision-makers and environmental managers with convenient access to the information

they need. They will be able, for example, to specify any particular area of the world, and then call up data for that area on such variables as soil type, forest cover, water resources, roads and other infrastructure, human, livestock and wildlife populations, climate, pollution, vegetation cover, and even the numbers of cows or cars per inhabitant.
But GRID's real strength will go far beyond this. GRID will be a powerful tool for environmental modelling and analysis. Those using it will be able to ask detailed and specific questions which involve overlaying information from many different data sets.

VI AGROMETEOROLOGY

913 91 - 6/20

Agrometeorology
Review, book, climate change, plant genetic resources

JACKSON, M. et al.

Climatic change and plant genetic resources.

Bellhaven Press, UK, ISBN 1-85293-102-7, 1990, £27.50

The volume addresses one of the lesser known aspects of climate change and is a welcome addition to the literature. In addition to matters genetic it contains a valuable amount of information on agricultural meteorology. Based upon a workshop held at the University of Birmingham in early 1989 the book presents a series of reviews, topped and tailed by two introductory chapters (on the subjects of the title) and a brief summary.
As an agricultural meteorologist I approached the topic of genetics with trepidation and panic but the introductory chapter is reader-friendly and, with a bit of effort, very informative. A particular point in this chapter is the mention of the additional vulnerability of crops to climate-change induced changes in pathogens. The speed of climate change is crucial; if it is too fast for plant breeders to cope then our initial response 'may well be to move existing cultivars about as in a game of chess'. Genetic manipulation is making great strides but may not able to achieve a rapid response because identifying, isolating and then cloning the appropriate genes is not straightforward.
The second introductory chapter gives a good overall picture - uncertainties included - of likely changes in climate. The important distinction between equilibrium and transient models is described and a very valid point is made about analogues of future climates - our current climate system may not have any. The author of this chapter was a contributor to the Intergovernmental Panel on Climate Change.
The following five chapters each contain a mixture of genetic and agricultural meteorology and are worth reading by disciples of either. Topics covered include: photosynthesis, changes in plant population/composition in the UK (a wide ranging chapter including a study of plant-climate relations by examining the distribution of aspects (north facing, south facing etc.) they inhabit; there is also the prediction that vegetation changes will take place in spurts, rather than gradually, as a response to runs of years with extremes of climate); and the already well-reported IIASA study on agricultural impacts. This section also has the two largest chapters which are also particularly worth attention, exploring the relation between genotype and climate and utilizing that relation in crop selection programmes.
The remaining chapters are more clearly devoted to genetic resources - their use in forestry, their use to counter the

effects of climate change and their conservation in the face of it.
To bring matters to an end there is a concise (four page), readable summary of the conclusions reached by the two-day workshop - including a list of suggested actions for both agricultural and meteorological scientists. This is a book well worth the attention of those scientists.
Abstract by C.J. Hume.

914 91 - 6/21

Agrometeorology
Review, article, tropics, micrometeorology, on-farm, weather advisory

STIGTER, C.J. and A. WEISS

In quest of tropical micrometeorology for on-farm weather advisories.

In: Agric. for Meteorology, 36, 1986, pp. 289-296

This paper marks the birth of the Traditional Techniques of Microclimate Improvement Project in 1985, for which it is the first attempt at the international level to word the rationale. The editorial starts from the observation that the current world economic conditions look grim enough to foretell that low-input agriculture will dominate, for a long time to come, a major part of the Third World production by small farmers. In this paper for the first time the distinction is made between weather forecasting for agriculture, agrometeorological forecasting and weather advisories. The latter may be defined as a production advisory regarding use or manipulation of meteorological conditions, in or close to the space occupied by crops and animals or their products, to increase quantity and quality of crops, animals and yields and their protection as well as that of the production environment. It is stated that if the latter become operational they will be the most powerful tool to meet the needs of low-input agriculture. Problems faced with this approach are outlined. Subsequently the contribution micrometeorology can provide is highlighted. Discussing the implications of such a contribution it is stated that in the training of tropical scientists in experimental agriculture, education in agricultural meteorology should be fostered. Such agricultural meteorology should also be part of aid programmes with educational and research components and of scientific and technical cooperation projects with Third World institutes. The agro-ecology of tropical crop space management is in need of a larger micrometeorological component: as our contribution to face the challenges of the present food and development crisis. The categorization on which our bibliography is based, distinguishing 15 classes of manipulation of radiation, 16 classes of manipulation of heat and/or moisture flow, 12 classes of manipulation of mechanical impact of wind, rain and/or hail and two general examples is published here for the first time internationally.
Authors' Abstract

915 91 - 6/22

Agrometeorology
Africa, Nigeria, humid tropics, Alfisol, cowpea, microclimate, monocropping, intercropping, insect pest incidence, integrated pest management, IITA, CTA, WMO, FAO, UNDP

LAWSON, T.L. and L.E.N. JACKAI

Microclimate and insect pests population in mono- and intercropped cowpea (*Vigna unguiculata*, Walp.).

In: Proc. of the Seminar on Agrometeorology and Crop Protection in the Lowland Humid and Sub-humid Tropics, Cotonou, Benin; 1986, pp. 231-244

Tropical agro-ecosystems appear to be singularly conducive to a very diversified population of insects which, in many if not most cases, constitute serious pests to food crops of the region. In no case does this appear more striking than in the case of cowpea, (*Vigna unguiculata*, Walp) which seems to be particularly prone to insect attack from planting to harvest.
The questionable virtues of continuous use of chemical insecticides for crop protection, even where it may prove economical, have of recent given fresh impetus to renewed interest in the concept of integrated pest management, with a seeming revival of the classical use of cultural practices for insect control as a principal component of this approach. In the low input traditional and neo-traditional agriculture practised in much of the tropics in general and in tropical Africa in particular, the cultural methods of pest management consciously or unconsciously still occupy centre-stage in the practice of pest control. Burning of crop residues and mixed cropping have been cited as typical examples.
It is in the above context that two cassava-cowpea intercropping experiments were conducted to study the possible role of crop microclimate in regulating cowpea insect pest populations and crop yield and to determine possible ways to maximize or optimize the system. The insect population and its interaction with microclimate is discussed here.
The experiments were conducted at the International Institute of Tropical Agriculture (IITA), Ibadan Southwestern Nigeria. The area is characterized by a bimodal rainfall/moisture cycle with two corresponding cropping seasons from April to July (first season) and September to November/December (second season). The soils are predominantly alfisols, the type on which the study was conducted. Land preparation consisted of ploughing and harrowing and application of P and K fertilizers at the rate of 30 kg P_2O_5/ha and 30 kg K_2O/ha respectively.
The influence of microclimate on insect pests incidence in cowpea (*Vigna unguiculata*, Walp) was studied by mixed cropping cowpea variety TVx 3236 with two cassava varieties (TMS 30001 and TMS X) of dissimilar plant architecture, with monocrop cowpea as control.

By far the most drastic change in microclimate imposed by the different treatments is with respect to the incident light on the cowpea. A joint analysis of the microclimate and insect population data shows a clear association between the levels of infestation by thrips and the ambient light climate.
The trend in pod bugs appears on the whole similar to that of the thrips population.
The distribution of pod borers also indicates the same tendency of lower insect numbers in conditions of strongly attenuated light.
Although induced differential insolation strongly suggests itself as primary factor in the observed distribution of the insect pests in the different crop associations, changes in other ambient factors probably play a contributing role. The comparatively higher temperatures coupled with the greater vapor pressure deficit in the sole cowpea and the cowpea TMS X combination as compared to the cowpea - TMS 30001 association in 1982 very probably contributed to the comparatively higher population of bugs.
In the case of pod borer, the effects of more profuse growth and relative abundance of flowers in enhancing Maruca population in the sole cowpea as a result of better insolation would appear to be matched, to some extent, by the influence of cooler night temperatures and higher relative humidity of the crop mixtures on the insect population. This probably accounts for the relative stability in the Maruca population with respect to the various treatments as was mostly the case. The better soil moisture regime in the intercrop treatments may have also contributed to this. It is also conceivable in this case as in the case of the other insects, that the mechanical or 'barrier effect' of the cassava may have afforded some protection to the intercropped cowpea or played a confounding role in the observed population distribution.
Concluding, it can be said that in spite of the relative stability in intra-seasonal macro/mesoclimate particularly in the tropics, significant modifications in micro-climate can obviously be induced in crop canopies by spatial disposition and/or association of crops over a given surface area as this study clearly illustrates. Such modifications should have important implications with respect to the pest and disease complex as evidenced by the results discussed in the preceding sections.

916 91 - 6/23

Agrometeorology
Review, microclimate, basic concepts, horticulture, energy balance modifications, radiation balance, temperature, thermal convection effects, heat exchange, mulching

TANNER, C.B.

Microclimate modification: basic concepts.

HortSciences, 9, (6), 1974, pp. 555-560

This is one of the few papers existing on basic features of microclimate management and manipulation. It deals with the matter from the point of view of simple energy balance modifications, with emphasis on illustrations for conditions of horticulture. Radiation balances and heat belances are separately dealt with. Dew and frost formation are indicated to illustrate our understanding of radiation exchanges. Prediction of temperatures of leaves illustrate our understanding of heat exchanges. Examples given on influencing the radiation balance are the use of colored or reflective mulches, painting tree trunks white to cool them, using (reduction of) shade. Examples of influencing heat exchange come from wind modification: breaks increase temperatures of sunlit organs and wind machines increase temperatures of exposed leaves at night; plant population and planting pattern as well as pruning influence air movement, so mixing within and above the canopy and also the participation of any thermal convection effects, which are only important at very low wind speeds, in shaping the environment. The modification of the latent heat exchange is illustrated among other examples again by the use of wind shelter, now to influence plant water balance, and by wetting dry hot surfaces of sandy soil to lower the temperature and prevent tuber and seedling damages and of course by more common forms of irrigation. Subsequently heat flow into a substrate and the related subject of heat sharing are discussed with simple mathematics, introducing the concept of thermal admittance and highlighting the resulting surface temperature. This approach facilitates the understanding of the influence of any soil (surface) property or modification on what happens at and near the surface concerned, in relation to the thermal properties of the two media meeting. This makes manipulations at and near the soil surface one of the better quantitatively understood microclimate modification subjects, as follows from the relatively abundant examples given here on these aspects. Best examples are mulchings of all kinds, applying the widest definition to the concept of mulching, which includes wetting, draining, loosening and compaction. But the concept of thermal admittance of the atmosphere and objects in the air also helps to understand earlier conclusions on frost prevention by irrigation, heating and blowers.

917 91 - 6/24

Agrometeorology
Review, microclimate modification, vegetable, crop ecosystem, shading, row covers, plant spacing, windbreaks, heaters, irrigation, foam, bed shape, mulching, light reflection

OEBKER, N.F. and H.J. HOPEN

Microclimate modification and the vegetable crop ecosystem.

HortScience, 9, (6), 1974, pp. 563-567

This paper deals with factors to consider in developing ways to modify the plant microclimate and microclimate modification techniques for vegetable crops in the open field. Research on microclimate modification appears to be a promising field that will pay handsome dividends. Environmental influences of modifying techniques on plants are categorized as inductive (such as cold treatment of seedlings to increase flowering and fruiting), progressive (such as mulching to warm soils) and protective (such as wind breaks and row covers). A figure on microclimate modifying techniques distinguishes shading, row covers, plant spacing, windbreaks, heaters, sprinkler irrigation, row orientation, Co2 enrichment, foam, bed shape, mulching, light reflection (at the soil surface), seedling environments, drip irrigation, cultivation and thermal water, which are all shortly or more intensively dealt with. The more intensive ones are treated with examples under the headings: seed and seedling environs, mulching, row covers, irrigation, plant and row orientation, light regulation and CO_2 enrichment, all of course for vegetables. The fact that it is a review is illuminated by the 105 references. It is concluded that the development of many of these techniques occured through trial and error, often in a piecemeal manner and without a systematic approach to the total ecosystem. With abundant findings in plant physiology and the development of sound principles of micrometeorology, the horticulturist has unique opportunities to develop an integrated plan for making the (outdoor) vegetable ecosystem highly productive. It is clear that also the tropical small farm ecologist may profit from this approach, especially from the low external input techniques.

918 91 - 6/25

Agrometeorology
Review, report, arid zone, state of knowledge, research, mulch, windbreaks, dew, fog, shelterbelts, soil temperature, future work

WIJK, W.R. and J. DE WILDE

Microclimate.

In: Problems of the arid zone. UNESCO Arid Zone Series XVII, 1986, pp. 83-113

Arid zone research was laying the foundation for renewed scientific interest in the relations between extreme climate and protection of the agricultural environment in relation to development issues. With its more than 250 references this paper plays that role with respect to microclimatic issues, including topoclimate. The report wants to serve as a basis for planning of research and application of science in the arid zone in the near future with respect to microclimate and its relation with plant, animal and human life. After a general introduction and one on organization of current research and investigation, the present state of knowledge is presented. For our purposes (sub-)sections on irrigation, soil temperature, mulch, shelterbelts and windbreaks, dew and fog, the use of micrometeorological data in applied entomology and plant pathology and finally some remarks on microclimatology in relation to man and domestic animals are most important. A large section on future work and outstanding problems, written now thirty years ago, makes interesting reading. In general the more fundamental microclimatic studies are mentioned for promotion but in the section on microclimatic measurements in relation to plant pests and diseases many more particular problems are discussed, including quite some with manipulation and management aspects. The most interesting recommendation is on promoting the publication of monographs in microclimatology as a quantitative rational assessment of often conflicting data based upon the laws of physics and if possible physiology, to provide arid land civil engineers and agronomists with the information required for the planning and the lay out of a new project on land reform: irrigation, windbreaks, etc..
Shelterbelts, mulch and dew are mentioned as ripe for reassessment using the physical approach, based on the example of evaporation. In the discussion interesting brief reviews are given on microclimatic studies in Pakistan and India. In particular the latter, are very specific with respect to microclimate management and manipulation issues studied there since 1932: treating the soil with black and white powder to influence soil temperature; effects of sprinkling on vegetation surface temperature; effects of windbreaks; effects of shading; effects of evaporation suppressants. In a short concluding report to the advisory committee on arid zone research, at the end of the paper and based on its contents, it is stated that the developments of methods of conservation and most economic use of the scanty water resources

in the arid zone for maximizing food production, and techniques for assessing the factors controlling the water balance at the ground, assume a very special importance. Care is necessary to ensure that in microclimatic researches the experimental techniques are adequate for the particular purposes in view, it being equally essential to avoid oversimplification of techniques on the one hand as much as over-instrumentation on the other.

919

91 - 6/26

Agrometeorology
Africa, review, cassava green mites, natural enemies, agro-meteorological data, IITA, CIAT, WMO, UNDP, CTA

YANINEK, J.S. and A.C. BELLOTTI

Exploration for natural enemies of cassava green mites based on agrometeorological criteria.

In: Proceeding of the Seminar on Agrometeorology and Crop Protection in the Lowland Humid and Sub-humid Tropics, Cotonou, Benin, 1986, pp. 69-75

Since the introduction of cassava green mites (CGM), *Mononychellus tanajoa* (Bondar) complex (Acari: Tetranychidae), into Africa, these pests have spread rapidly throughout the cassava belt and now threaten production across much of the continent. Several methods were proposed for controlling CGM when first discovered in Uganda in 1971. Most of the original recommendations proved ineffective or inappropriate for this subsistence crop. The neotropical origin of these mites prompted hope that effective natural enemies could be found in the area of origin and introduced into Africa to control CGM.
In 1980 the International Institute of Tropical Agriculture (IITA) began the Africa-wide Biological Control Programme (ABCP) to control exotic pests of cassava using introduced natural enemies. The aim of this project has been to address the ecological imbalance found in the cassava ecosystem in Africa using classical biological control, i.e. the introduction of natural enemies from the pest's area of origin. The first task of the ABCP has been to locate promising natural enemies representing a range of ecological preferences. Once identified, these natural enemies are then screened as candidates for introduction and experimental releases in Africa. Given the large area affected by CGM in Africa and the extent of the regions that could be searched for CGM natural enemies in the neotropics, there is a need for a strategy to assure efficient and effective exploration. In this paper, a strategy for exploration based on agrometeorological criteria is considered.
IITA und CIAT developed such a strategy using agrometeorological criteria to identify ecological homologues in Africa and the neotropics. The present knowledge of ecological systems is insufficient to predict where a "useful" natural enemy can be found. Consequently, the search for natural enemies is still as much an art as a science. The available biological information is used to make educated guesses about where to search for "useful" species. Likewise, the strategy presented here is not a roadmap for finding "useful" CGM natural enemies. This strategy is simply an ecological guide to the type of areas in Africa where CGM are a problem, where imported natural enemies must be able to survive, and where natural enemy candidates for introduction might be found in the neotropics.

920 91 - 6-27

Agrometeorology
Review, Africa, Europe, microclimate modification, windbreaks, evaporation, air temperature, air humidity, radiation balance

GUYOT, G.

Les Brise-vent. Modification des microclimats et amélioration de la production agricole. (Windbreak. Microclimate modification and improvement of agricultural production.)

In: L'eau et la production végétale, INRA, Paris, 1963

This article is a summarizing bibliography and at the same time a review of the state of the art of the knowledge on the multiple and sometimes contradictory effects of windbreaks. It distinguishes the influence of windbreaks on the wind itself, on microclimatic factors like evaporation, air temperature, air humidity, radiation balance and CO_2-content of the air, on the soil (erosion, climate, physical properties). It also deals with hydrological influences of windbreaks (on rainfall distribution, run off and groundwater) and their influence on yields. With one publication from Belgian Congo and some from Israel, results under more tropical conditions are rather absent, as could be expected, but the many results from the Russian steppe regions compensate this somewhat. Disadvantages and advantages of windbreaks are distinguished. As negative factors for the wind protected crops, of course depending on the location and sometimes the orientation of windbreaks, are mentioned: shading of part of the protected crops, root competition between break and crop, higher springtime night frost risks, higher maximum temperatures and higher humidities, increase of harmful bird and insect populations and competition for space. As positive factors are mentioned: protection from mechanical damage, soil water conservation and water use efficiency increase by evapotranspiration changes, from which changes in other parameters (temperature, humidity, soil temperature and other physio-chemical factors) are partially derived as well, and finally increase in photosynthesis by longer stomatal opening. In cases where wind breaks increase both evaporation and temperature, such as with cereals in hot rain fed dry tropical areas, yield effects may be negative. In the other cases the yield increase differs with distance from the belt, with generally the highest increase where wind and evaporation are at their minimum. The most spectacular results have been reported with multiple belts in relatively dry climates with shallow rooting plants, such as in prairies. In the Russian steppes yield improvements of 100% with prairies have been reported.

921 91 - 6/28

Agrometeorology
Review, book, study, temperate climate, cold climate, semi-arid regions, agriculture, climatic change

PARRY, M.L. et al.

The impact of climatic variations on agriculture.
Vol. I: Assessment in cool, temperate and cold region.
Vol. II: Assessment semi-arid regions.

Kluwer Academic Publishers Dordrecht, ISBN 90-277-2700-7, 1988 876 pp., Vol. I USD 89.00, Vol. II - ISBN 90-277-2719, USD 89.00

The two volumes are the outcome of a research project based at the International Institute for Applied Systems Analysis (IIASA) and funded jointly by IIASA and the United Nations Environmental Programme (UNEP) as part of the World Climatic Impact Programme (WCIP), which was initiated by the World Meteorological Organization (WMO) in 1979.
The purpose of the study is to investigate the effects of climatic change and variability on agriculture and to evaluate alternative responses to these effects. While it is not yet possible to forecast how the climate may change, the potential consequences of each of a number of possible climatic changes is studied with greater emphasis on the effects of likely long-term CO2-induced changes of air temperature in Volume 1 and short term variations, especially droughts, in Volume 2.
This division is justified, for in the less developed countries of the semi-arid regions, the economic effects of short-term extremes, especially droughts, are generally more severe than in the highly developed agricultural systems of the cool temperate and cold regions, were long-term climatic change will likely result from increasing concentrations of carbon dioxide and other radiatively active gases. In the semi-arid regions, located at lower latitudes, the predictions of future climate based on the general circulation models suggest that CO2-induced changes in air temperature will be significantly smaller than those at middle and high latitudes.
In the study a hierarchy of models is used, to assess the effects of climatic variations on agriculture. Included are models of climatic variations based on the analysis of instrumental records as well as on the results from the global circulation models, biophysical models of first order relationships between climatic variables like temperature, precipitation etc. and biomass productivity, economic models of second order relationships considering the effects of productivity change on farm profitability and economic models of higher order relationships between farm profitability and regional employment. Policy responses to the consequences of the climatic change at the regional, national and international level are investigated too.
The additional effects of climatic variations on pests and diseases, soil structure, soil nutrients, soil erosion,

salinization etc. are considered as well as effects of soil moisture, groundwater depletion, desertification, acid deposition etc. reinforcing the climatic changes themselves.
In order to test the methodology in the research context, a number of case studies were elaborated including a variety of geographical locations near the limits of agriculture with respect to rainfall and temperature and belonging to centrally planned, market oriented and subsistence economies.
The regions chosen as case studies considering the CO2-induced climatic changes at higher latitudes were: Saskatchewan (Canada); Iceland; Finland; the Leningrad, Central and Cherdyn regions of the northern USSR and northern Japan.
The case studies for semi-arid regions with a high vulnerability to drought were conducted in the central Sierra of Ecuador, northeast Brazil, central and eastern Kenya, dry tropical India, the Stavropol and Saratov regions of the southern European USSR and the Australian wheat belt.
In each case study a team of between four and seven scientists and policy advisers of the countries, where the test areas are located, performed the experiments and submitted results.
A shift to a long term warmer climate, even when precipitation increases as predicted by the CO2 experiment, would reduce spring wheat yields by about 16%, causing annual losses to agriculture of over Can$ 160 million and 700 person-years unless there were major adaptive adjustments in agriculture. The warmer climate might reduce wind erosion potential and increase average biomass productivity, but at the same time droughts could become more frequent and severe. If the climate warming will not increase the precipitation totals as predicted, all the impact would be generally adverse and more intense, particularly drought frequency and severity. The development of new crops and management techniques more suited to the changing environment are needed.
The case studies of the second Volume have two goals: to improve the adaptation of agriculture to climate variability now, and to establish the basis for appropriate adjustment of agriculture to possible climatic variations in future.
The first case study presents a detailed climate impact assessment for central and eastern Kenya. The results are given according to the five agroclimatic zones of the study area for a good year, average year, moderate drought year, severe drought year and successive years with drought. In the tea-coffee-zone the maize yields in good years are 2400 kg, in severe drought years less than 250 kg. In the marginal cotton zone these values range from 1000 kg to 0 kg. The case study emphasizes the need to consider the whole chain of events from a meteorological drought through the human consequences and responses. Integrated assessments are needed in order to identify linkages which are critical to policy interventions to reduce individual and national vulnerability to drought.
The case study of the central Sierra of Ecuador recognize that the agriculturally oriented economy is highly vulnerable to severe droughts and occasional frosts or floodings. Farmers are already coping in an appropriate manner with climatic variability. The observed barley-potatoes crop mixtures serve to smooth payoffs

over time and minimize risks. In general, potatoes do better in wet years and barley in dry years. To make preliminary estimates of the effects of variations of precipitation on barley yields, the CERES-Wheat growth simulation model was adapted for barley in the highlands of Ecuador. In all years the model estimated higher yields for middle and late planting dates. Under dry year conditions the model estimates for early planting dates near zero yields, owing to flowering and grain filling during periods of extreme drought stress. Under all climatic conditions different from the present, the potential area of good yields contracts in the model estimates. The contraction is greater during years with excess rainfall than during dry years.
The Indian agriculture depends strongly on the monsoon rainfall. The analysis of the variation of rainfall over the country as a whole does not reveal any long-term changes from 1871-1978. The inter- and intrayear variability of rainfall in the semi-arid region chosen for the case studies ranges from 350 to 1500 mm, and limits the period available for crop growth to roughly 50-200 days. Farmers have adapted to protect against drought rather than to respond to high rainfall. As a result farmers devote a large proportion of their annual crop production to post rainy cropping, so that the crops are raised on the residual moisture of the soil. This practice had led to severe soil erosion as bare lands are exposed during the rainy season. When precipitation exceeds in good years 750 mm and the moisture storage capacity of soils exceeds 150 mm, the cultivation of two crops is possible if the seeding of the first crop is performed early in the rainy season. Traditional risk protecting methods are loosing their effectiveness in the face of rising population pressure. New technologies have to be adopted to use the potential for higher productivity under the same soil-rainfall conditions.
The results presented in the case studies, while preliminary, suggest that a modelling approach such as used in the studies,if developed further, could serve as a useful tool for agricultural planning under changing climatic conditions. The absolute values of the predictions are highly speculative owing to uncertainties in the climate, biological and economic models, and because of the long time period of projections especially in the case of doubling the CO2 content of the atmosphere. Nevertheless these models are currently the most appropriate tools with which a future climatic change and its impacts can be assessed.
Abstract by D. Klaus, shortened

922 91 - 6/29

Agrometeorology
Review, book, climatic change, carbon dioxide

IDSO, S.B.

Carbon dioxide and global change.

IBR Press, Tampe, AZ, ISBN 0-9623489-1-0, 1989, 292 pp., price USD 19.95

This book is highly recommended to anyone who is involved with agriculture. Most professionals in the agricultural community are well aware of the 'greenhouse effect'. This phenomenon, somewhat a misnomer, is a 'hot' issue in the popular and scientific press, and opinions on the importance and urgency of this problem vary markedly. This timely comprehensive book presents Dr. Idso's ideas on the physical and biological effects of increases in CO_2 in the earth's atmosphere. It can be read in an evening or two (there are 135 pages of text), or, if one so chooses, one could spend months reviewing the approximately 2000 references that are cited. The book is easily read and is appropriate for lay and scientific audiences.
The book is composed of two parts. In the first part, Dr. Idso discusses two diverse perspectives on the implications of increasing CO_2. On one side is the consensus opinion of the global-climate modelers that the earth will warm by a few degrees if the atmospheric concentration of CO_2 increases to approximately 600 ppm. This warming has led some to postulate significant and dire consequences (e.g. coastal flooding due to rising ocean levels, shifting of major agricultural production zones, etc.). Dr. Idso then presents his view, namely that there are empirical data which, in his opinion, raise serious questions as to whether the results from climate models can be believed and whether these results should be used to make significant policy decisions. The first part of the book concludes with a review of recent work attempting to detect the first effects of climate change.
The second part of the book, less controversial but perhaps as important, discusses the biological implications of increases in atmospheric CO_2. Perhaps the greatest value of this book lies in its thorough discussion of the direct effects of increasing CO_2 on vegetation, an important issue that has not received adequate attention in the scientific and lay press. Some of these effects are well-established and direct (e.g. increasing plant water-use efficiency), and some are somewhat more debatable (e.g. improving the quality of groundwater supplies). However, as is the case throughout the book, Dr. Idso has thoroughly thought through the arguments and supports statements with citations from the scientific literature.
The second part of the book concludes with a discussion of the effects of increasing CO_2 on the ability of plants to withstand stresses (e.g. water deficits, low and high temperatures, air

pollution, and soil infertility) and the direct and indirect effects of increasing CO_2 levels on animals.
Dr. Idso has collated much of the published work on this subject into one book. His personal biases are stated and the reader is aware of his mission in writing this book. He is to be commended for seriously challenging the consensus within the global-climate (meteorological) scientific community and encouraging them to critically look at their assumptions and theories. The positive and negative implications of rising CO_2 levels are likely not trivial (and, perhaps, may be of equal importance) and we, as professionals, need to be aware of the arguments from the major factions in this debate. This will enable us to provide the guidance and technical information needed by administrators and policy makers. As Dr. Idso states in the Preface, "We cannot begin to broach them (problems associated with rising CO_2) until we truly understand them." In this book Idso has succeeded in attempting to increase our understanding of these problems.
Abstract by WM.A. Dugas, USA.

VII **AGROFORESTRY**

923 91 - 7/59
Agroforestry
Review, environment, sustainable land-use, erosion control, soil fertility, soil degradation, multipurpose trees

YOUNG, A.

Agroforestry, environment and sustainability.

Outlook on Agriculture, 19, No. 3, 1990, pp. 156-160

This paper is concerned mainly with direct environmental implications: how to combine production with conservation of natural resources.
Sustainability means continued production, at levels at or above those of today, coupled with conservation of the natural resources on which that production depends.
There is an essential difference of emphasis from the concept of environment which came to the fore in the late 1960s. At that time the emphasis was on conservation, sometimes regarded as an end in its own right. This is not the way in which smallholder farmers in less-developed countries look at things. For them, feeding the family, and providing for other essential needs, come first. Certainly, they realize that their livelihood depends on the soil, pastures and forests, and appreciate the need for conservation if future needs are to be met; but this year's harvest takes priority, and if it comes to the crunch, natural resources will be exploited and degraded.
Sustainability puts production as the primary objective. In development planning, whether at farm, village or regional level, short-term production requirements must come first. Only if and when these have been satisfied can we turn our attention to the conservation necessary to sustain production in the longer term.
The nature of agroforestry is now quite widely understood. It refers to a range of land use systems in which trees or shrubs are grown together with herbaceous plants (plants or pastures), associated in space and/or time, and in which there are both ecological and economic interactions between the tree and crop components.
Agroforestry encompasses a wide range of land use practices, having in common the interactive role of trees. There are some 20 distinct technologies, or arrangements of trees and crops in space and time, and many thousands of agroforestry-based land use-systems.
This diversity is one of the key features in the potential of agroforestry. Where one technology proves to be ill-adapted to local conditions, others can be identified, matched to the environment and needs of a land use system: fodderbanks where there is a shortage of dry-season pasture, for example, or border planting of fuelwood species where forests have been cleared.

Current research into its development potential emphasizes the problem-solving role of agroforestry. The method employed by the International Council for Research in Agroforestry (ICRAF), and adopted by many development agencies, is based on the approach of diagnosis and design. This begins with on-farm diagnosis, and identification and analysis of the problems of land use systems. These are of two kinds: problems of the farmer and problems of the land. Those of the farmer are needs for production, such as shortages of food, fodder, fuelwood, as well as low income. The problems of the land are those of environmental degradation, of soils, pastures or forests. Almost every single diagnosis and design study known to ICRAF has identified low or declining soil fertility as a problem. The causal links between problems of land and of the farmer are obvious, frequently with population increase on a finite land base as the initial trigger to a vicious circle of resource degradation and declining productivity.
The paper deals in detail with the following aspects:
- Multipurpose trees
- Agroforestry for soil conservation
- Control of erosion
- Maintenance of soil fertility
- Vegetation resources
- Agroforestry inland use planning and watershed management

Finally the need for research is underlined.

91 - 7/60

924

Agroforestry
Review, book, tropics, Asia, Pacific, Africa, Latin America, classification, agroforestry systems, environmental protection, multipurpose trees, ICRAF

NAIR, P.K.R.

Agroforestry systems in the tropics.

Kluwer Academic Publishers, Dordrecht, The Netherlands, in Cooperation with ICRAF, Nairobi, Kenya; ISBN 90-247-3915, 1989, 609 p.+ Appendices

Throughout the world, it has been the practice to cultivate tree species and agricultural crops in combination. The examples are numerous. It was the general custom in Europe, at least until the Middle Ages, to clear-fell forest, burn the slash, cultivate food crops for varying periods on the cleared areas, and plant or sow tree species before, along with, or after the sowing of the agricultural crop.
For the purpose of this book, the word tropics is used in a general sense to also include subtropical developing countries that have agro-ecological and socio-economic characteristics and land-use problems similar to those of the countries within the geographical limits of the tropical belt.
In Asia, for example the Hanunoo of the Philippines practised a complex and somewhat sophisticated type of shifting cultivation.
The situation was little different in Africa. For example in southern Nigeria, yams, maize, pumpkins and beans were typically grown together under a cover of scattered trees.
These examples indicate the wide geographical coverage of the system and its early origins. They clearly point out the earliest practitioners of what has now become known as agroforestry.
Trees were an integral part of a farming system.
In tropical America, many societies have traditionally simulated forest conditions in their farms in order to obtain the beneficial effects of forest structures.
The book does not include or cover all existing agroforestry systems in the tropics and geographical regions in the tropics. Some of the systems described are outside the tropical boundaries of 23.5° N and S latitudes.
The basic consideration of this book was to include examples of systems from as many geographical and ecological regions as possible.
This state-of-the-art account of agroforestry systems in the tropics and subtropics is one of the significant outputs from ICRAF's recently completed global inventory of agroforestry systems.
The exercise consisted of collection, collation, synthesis, evaluation, storage and dissemination of information,and the data collection and synthesis involved a large number of institutions

and individuals interested in and knowledgeable about agroforestry from all over the world.
This book offers the descriptive results of a project called Agroforestry Systems Inventory (AFSI).
These system descriptions form the bulk of this book.
In addition to the many (over 25) descriptions of agroforestry systems from different parts of the world that had been serialized in Agroforestry Systems, the book consists of other useful informations such as classification of agroforestry systems, ecological analysis of their spread, and salient aspects of some agroforestry technology innovations.
The book presents the diversity and complexity of tropical agroforestry systems. The descriptions and their analyses show their potentials on the one hand, and the gaps in the understanding of these systems on the other. This points out the need to undertake systematic research efforts to fill these gaps and improve the functioning of these low-input traditional systems.
The various authors who contributed the system descriptions have been indicated by name in the respective chapters.

925 91 - 7/61

Agroforestry
Latin America, Central America, humid tropics, sustainable development, pilot model, cocoa, research trials, training programs, extension, institutional support, technical cooperation, technology transfer

CORVEN, J.M. and G.E.VILLANUEVA

Regional agricultural networks for sustainable development: PROCACAO as a pilot model.
Program II: technology generation and transfer.

Publ. of the Inter-American Institute for Cooperation on Agriculture, San Jose, Costa Rica; 1991, 10 p.

Cocoa (*Theobroma cacao*) has been a traditional crop of Central and South American peoples for thousands of years and current production occupies nearly 25,000 hectares (42,000 acres) in Central America alone. Under traditional field practices which represent little more than planting and harvesting, current cocoa yields in Central America average 200 to 400 kg/ha per year. These very low yields coupled with low world market prices since 1987 have pressured marginal farmers to convert their land to annual cropping systems that may be environmentally threatening.
Improved small-scale commercial cocoa farming is a sustainable enterprise for the humid tropic lowlands in many developing countries. As an indigenous understorey tree species of the American rainforest, cocoa is ecologically sustainable because its cultivation preserves natural diversity, promotes soil conservation, and is an economic management strategy of the rainforest. Socially cocoa is suitable for the family farm in terms of its labor and low input requirements while offering modest, low risk, long-term economic returns to independent farmers. Cocoa offers a realistic opportunity to generate national revenues as an export commodity as well as local production of diverse products including inexpensive, nutritious beverages and natural flavorings and colorings.
The general objective of the project is to increase cocoa productivity and the income of small and medium-scale cocoa farmers in Central America and Panama. This has been realized through a regional network that improves the quality of research and access to new technical information by extensionists and farmers. Secondarily, the project is to learn how best to establish and operate a regional agricultural network, possibly for the benefit of other crops or future development projects.
The Regional Network for Cacao Technology Generation and Transfer (PROCACAO) is examined as a pilot model for development strategies where resources are scarce and poorly integrated. Using cocoa, a native tree crop in the humid tropics, as its focus, the collaborative network of eight Central American nations, three research institutions, and national advisory organizations with strong private sector support is discussed. Project results

include research trials in genetic improvement, field practices, postharvest management, training programs and publications in support of national extension planning and development, and institutional strengthening through reciprocal technical cooperation. Several considerations for replication of the model are discussed.
As a regional network this pilot project is able to integrate, strengthen, and apply available resources to the mutual benefit of all participating countries. The result has been improved research programs at regional, national and on-farm levels, better trained extension services, and perhaps most critical, opened channels of communication for information exchange and coordination through national multi-sectorial advisory organizations.

926 91 - 7/62

Agroforestry
Review, farming systems, sustainable development, integrated approach, resource conservation, agroforestry practices, rotational systems, mixed systems, tree garden systems, zoned systems, shelterbelts, windbreaks, shade trees, biomass transfer, silvopastoral systems

WOOD, P.J.

The scope and potential of agroforestry.

Outlook on Agriculture, 19, No. 3, 1990, pp. 141-146

Agroforestry is most effective in farming systems when used to solve specifically identified problems.
This paper summarizes the main ways in which a variety of practices can provide benefits both in the form of produce, for home use or as cash crops, and as services, to improve or sustain the environment.
Agroforestry may be regarded as the study and exploitation of the interactions between trees and crops and of both with animals, when they are grown together on the same unit of land. It means, the technology of using trees on farms, or the activities of farmers in forests.
The traditional practices of intercropping and the managed home garden systems that have been developed by small farmers, are good examples of agroforestry systems.
Community forestry and social forestry, in which plantations or forests are managed by and for rural communities, are important aspects of rural development forestry, but they are not necessarily agroforestry.
In contrast with traditional forestry which tends to be more concerned with growing trees in stands or forests, small farmers are much more concerned with individual trees or small groups of trees. A truly multi-disciplinary approach is needed, relying on the skills of the agronomist, horticulturist, sociologist and meteorologist as well as the forester.
The place of agroforestry within the discipline of present day forestry is indicated schematically in this paper.
The agroforestry practices discussed in detail are:

- Rotational systems:
  In tropical agriculture the main application of agroforestry is in the use of woody perennials in tree fallows, whether these be in shifting agriculture or on permanent farm land.
- Mixed systems:
  The use of woody perennials intermixed with agricultural crops is widespread in the tropics and subtropics.
- Tree garden systems:
  Home gardens or multistorey tree gardens require perhumid (i.e. lacking a dry season) or subhumid climates, and have generally been developed without scientific intervention.

- Zoned systems:
  Hedgerow intercropping, otherwise known as alley farming or alley cropping appears to be most successful in high rainfall zones where annual cropping is practised.
- Trees for soil and water conservation:
  Woody perennials can be used in controlling soil erosion and sustaining soil fertility. The use of trees in association with solid conservation works can also provide fodder, wood and food for home consumption or for sale.
- Shelterbelts, windbreaks and shade trees:
  The technology of using shelterbelts is well known in temperate regions and is becoming increasingly so in the tropics.
- Trees for biomass transfer:
  The use of trees in separate woodlots is one of the commonest forestry practices. The use of such plantations in agroforestry can provide leaf manure as well as fodder, poles, fuel and timber.
- Mixed systems:
  The retention of trees on rangelands is common where the benefits to livestock in providing dry season fodder are understood.
- Special agroforestry applications:
  Special applications of agroforestry which may be of great local importance include beekeeping and fish farming, for example in mangrove forests.

927 91 - 7/63

Agroforestry
Review, land-use institutions, policy aspects, ICRAF

LUNDGREN, B.O.

Institutional and policy aspects of agroforestry.

In: Agroforestry Systems in the Tropics; Ed. P.K.R. Nair; Kluwer Academic Publishers, Dordrecht, The Netherlands in Coop. with ICRAF, Kenya; 1989, pp. 601-606

The basic institutional structures established to deal with the use of land in virtually all the countries of the world today originate from temperate Europe and North America.
Crop production and industrial wood production, which were carried out on separate types of land, had different aims. It was entirely rational that agricultural and forestry institutions developed independently of each other.
As a result of these separate institutional developments, there are today different laws and policies governing agricultural and forest land use.
Another important aspect of the land-use legacy from the industrialized countries is that all policies are aimed at maximizing.
When the European colonial powers established their administrations in tropical and subtropical regions, the institutional structures, policies and aims related to land use and development used in the home countries were simply copied in the colonies.
A significant contributor to the failure to solve many important land-use problems is the inappropriateness of conventional-discipline-oriented institutions for identifying and addressing real problems in land-use systems in most developing countries.
This particularly applies to the multitude of subsistence or mixed subsistence/cash farming and pastoral systems in which the vast majority of rural land users live.
These conventional institutions are geared to the maximization of individual components, be they food crops, cash crops, animals or trees. There is little understanding that the land user needs to share out his resources for the production of other commodities or services.
There is no institution today which has both the mandate and the competence to identify solutions to land-use problems based on an interdisciplinary analysis of interactive constraints, and the power to assign resources in a way that will cut across institutional boundaries in order to implement such solutions.
There are a few positive signs that awareness of the need to address the institutional constraints to real problem-solving is increasing.
Less encouraging is the fact that virtually, all recent policy and planning documents from international institutions end up making conventional recommendations such as increased use of fertilizers,

irrigation and genetically improved crop varieties, increased tree planting, etc.
There is an urgent need to re-think and re-evaluate the situation.
Some general institutions and programmes needed for tomorrow are listed in this paper:
- Collaborative programmes which cut across disciplinary boundaries and address concrete land-use problems must be encouraged and given more support.
- The need for specialized institutions and experts - the plea for multidisciplinary, inter-institutional approaches and integrated thinking.
- The need for new institutional functions for problem identification, priority setting and resource allocation, without necessarily making fundamental changes of structure.

928

91 - 7/64

Agroforestry
Asia, India, study, alkaline soils, land productivity, fodder crop, forage yield, ICRAF

SINGH, G. et al.

Agroforestry for alkaline soils.

Agroforestry Today, 3, No. 1, 1991, pp. 10-11

Salt-affected soils reduce the productivity of more than 900 million hectares of land around the world. In India, such soils occupy an area of about 7 million hectares. About one third of the reported salt-affected soils in India are alkaline, characterised by high pH, high exchangeable sodium, low fertility, dispersed particles and very poor water-transmission characteristics. Most of these soils do not support any vegetation at all except a few wild species such as *Salvadora persica*, *Capparis aphylla*, *Prosopis juliflora*, *Acacia nilotica*, *Desmostachya bipinnata*, *Sporobolus* spp. and *Suaeda maritima*.
Alkaline soils in India are often found in communal lands in villages, along railway tracks and roadsides, and around government departments. Today these marginal lands contribute very little to national income. Agroforestry could be a promising land-use for such sites, particularly in view of the growing scarcity of fuelwood and fodder as well as pressing environmental considerations.
Work has been progressed at the Central Soil Salinity Research Institute in Karnal for the past 10 years to develop a viable agroforestry system to make better use of these marginal lands. A long-term field study was initiated in 1984 on an abandoned alkaline soil (pH 10.4 and exchangeable sodium 90%) belonging to the Panchayat (a village judicial body) of Gudha village in Karnal District.
Results indicated that abandoned alkali lands can be improved by growing *Prosopis juliflora* trees together with *Leptochloa fusca* (Karnal grass) in a unified agroforestry system. Leptochloa grown in association with prosopis produced 46.5 tonnes of green fodder per hectare in 15 cuttings over a 50-month period without any fertilizer or other soil amendments.
These two species improved the soil to such an extent that it was possible to plough under the leptochloa after four years and grow less tolerant but more palatable fodder species, such as *Trifolium resupinatum*, *T. alexandrinum* and *Medicago* spp., under the prosopis trees. The green forage yields from these species were comparable to yield levels achieved in this region in normal cultivated soils.
The prosopis also produced fuelwood, obtained by cutting side branches intermittently. On fields where prosopis was planted at a spacing of 5 x 3 metres, total fuelwood yield was 7.7 tonnes per hectare over 52 months.

After 52 months under prosopis and leptochloa, soil pH decreased from 10.3 to 9.4 and electrical conductivity decreased from 2.20 to 0.42 decasiemens (dS) per metre. Organic carbon in the topsoil increased from 0.18 to 0.43% and available nitrogen increased from 79 to 139 kg per hectare. The phosphorus and potasium status of the soil decreased slightly, but water transmission improved.
These results suggest that prosopis and leptochloa are highly tolerant to alkali conditions. When planted together, their potential for fuelwood and forage production make them potentially useful species for exploiting abandoned alkali lands not readily or economically reclaimed by conventional techniques. In situations where soil amendments are either very expensive or simply not available, this biological approach may be the only viable method for improving and managing salt-affected soils.
Authors' Abstract.

929 91 - 7/65

Agroforestry
Review, soil fertility, erosion control, sustainability, land-use practices, smallholder, research needs, CTA, ODA, ORSTOM, USAID

YOUNG, A.

Agroforestry for sustainability on steeplands.

In: Proc. of a IBSRAM Workshop, Thailand; IBSRAM Proceedings No. 8, 1989, pp. 37-49

The aim of this paper is to outline the potential of agroforestry for soil conservation.
Appropriate agroforestry systems have the potential to control erosion, maintain soil organic matter and physical properties, augment nitrogen fixation, and promote efficient nutrient cycling.
Appropriate means systems which are fitted to local environmental conditions, well designed, properly managed, and which are applicable within the constraints, and meet the needs of farmers or other land users.
The primary aim of soil conservation is the maintenance of fertility, for which control of erosion is one necessary condition, but also soil physical conditions and nutrient status are equally important. Agroforestry refers to land-use practices in which trees or shrubs are grown in spatial or temporal association with crops or pastures, and in which there are both ecological and economic interactions between the tree and nontree components. It is a practicable management option for small farmers and a relatively inexpensive form of land development. In erosion control, agroforestry can contribute both to the barrier and the cover approaches. Agroforestry practices can be employed in erosion control either alone or in conjunction with earth structures. Trees improve soil fertility by maintenance of organic matter, nitrogen fixation, uptake and recycling of nutrients, and other processes. There is substantial evidence, in part qualitative or indirect, that agroforestry can contribute substantially to the maintenance of soil fertility. Research specifically directed towards agroforestry is recent, hence there are few experimental results to date.
The paper shows that there is a considerable apparent potential, coupled with a scarcity of experimental data. Therefore one aim of this paper was to indicate the research that is needed if this exciting prospect is to be set on a sound scientific basis.
The following conclusions have been drawn by the author:
Agroforestry is both a practical management option for farmers in less-developed countries, and a relatively inexpensive development option for governments and international agencies. The benefits are by no means limited to effects upon the soil, but include both production (e.g. of fuelwood, fodder and fruit), and other service functions such as shade and fencing. Thus it has the potential to combine soil conservation with production, under conditions within the reach of farmers with small landholdings and little capital.

There are substantial grounds for supposing that agroforestry systems of land use can help to control erosion, maintain soil fertility, and thereby lead to sustained production.
The agroforestry practices which have a particular potential for either the control of erosion or the maintenance of soil fertility, are listed.
Experimental evidence in support of the potential of agroforestry is scanty. Putting these conclusions together, agroforestry practices are known to provide practical management and development options. There is a large and growing problem of soil degradation, including both erosion and a decline in fertility. This is coupled with a considerable apparent potential for control by means of agroforestry; but there is a lack of controlled experimental data.

930 91 - 7/66

Agroforestry
Africa, tropics, study, moist forests, management practices

FAO

Management of tropical moist forests in Africa.

FAO Forestry Paper No. 88, Rome, FAO, 1989, 165 pp.

The Forestry Department of FAO has commissioned several studies on tropical forest management.
The present study applies to tropical forest managment in Africa.
This study covers mainly the lowlands, but has been extended to include the semi-deciduous tropical forest at rather higher altitudes. Mention is also made of the montane closed forests of Kenya and Tanzania.
Management requires clearly defined objectives; that the objectives must be realistic and may need to be modified in the light of biological, social, economic or political constraints; and that management must make the best use of available resources in achieving the objectives.
Natural forest management may be thought of as controlled and regulated harvesting, combined with silvicultural and protective measures to sustain or increase the commercial value of subsequent stands, all relying on natural regeneration of native species.
The present paper covers all management systems which retain tropical forest management sites for forestry purposes. It therefore includes management of the mixed natural forests using natural regeneration, use of enrichment planting in combination with natural regeneration, and conversion of the natural forest to monoculture forest plantations.
The environment of modern forest management in the tropics is dominated by people and their needs. Full understanding of the physical and ecological factors are still as vital as ever, but no management diagnosis that excludes a detailed analysis of the local and national social and political elements has any practical relevance. Prediction of future trends in these elements has become a necessary but difficult and risky task.
The management of a forest enterprise can be considered under four major heads:
- Physical, biological, ecological and environmental factors;
- Social - including the political and cultural facets as well as local and national needs;
- Economic - including constraints on the capital and recurrent budgets, rate of return, costs, prices, trade and markets;
- Technological factors and their rate of change in silviculture, harvesting and wood processing.

From its inception FAO has continuously supported management based on natural regeneration for timber and other products in tropical moist forests.
The primary purpose of these Forestry Papers is to document and synthesize the results of work that has gone before, thereby

providing an extremely valuable pool of information for designing current programmes on natural forest managment.
Forestry Paper No. 88 on Africa is based on several national studies that were broadened by forestry experts in French- and English-speaking Africa.
The result is a unique combination of French- and English-speaking African forest management experience.
These Forestry Papers supply valuable detailed information and sources for further study for those technically involved in natural forest management in the tropics, and a good general background on practical forest management for all those interested.

931 91 - 7/67

Agroforestry
Review, book, humid forestry, tropical forestry action plan, evaluation, WRI, ICRAF

WINTERBOTTOM, R.

Taking stock: the Tropical Forestry Action Plan after five years.

Publ. of the World Resources Institute, Washington D.C. USA, 1990, 59 pp., price USD 7.50

The Tropical Forest Action Plan (TFAP) was launched five years ago by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the World Resources Institute. It arose from a widely shared concern that uncontrolled deforestation and wasteful depletion of tropical forest resources could be reversed with more effective programmes in forest conservation and sustainable management, increased attention to policy reform within and outside the forestry sector, and improved land-use planning and coordination with agricultural and other development programmes.
Since 1985, more than 40 aid agencies have supported more than 50 country-level forestry sector reviews and forestry funding commitments have at least doubled, to more than US$ 1 billion a year. However, according to this report, only 8 of the 27 countries that had initiated forestry action plans as of 1986-88 have formally adopted these plans and presented them for donor support. Furthermore, the needs and roles of forest dwellers, indigenous peoples and local communities have been neglected. Finally, key opportunities for slowing net deforestation are not being addressed. This could involve launching policy and institutional reforms, reallocating resources, or mobilizing the private sector as well as non-governmental organizations.
This report recommends four goals designed to address the basic causes of deforestation:

- The planning process must meet the needs and safeguard the livelihoods of people who live in or depend on tropical forests.
- Plans should help ensure that the remaining areas of tropical forests are used on a sustainable basis, contributing to national development while at the same time encouraging the multiple uses of forest lands and the effective protection of biological diversity.
- Resources should be mobilized to regenerate degraded tropical forest lands, using indigenous species to the greatest extent possible, and to promote sustainable land use around tropical forest areas.
- Policy reforms are required, both in tropical countries and in development-assistance institutions.

The report concludes that a deeper commitment is needed to broaden participation in the TFAP planning process and to expand the role of local communities in the managment and conservation of tropical forests.
The report may be ordered from: World Resources Institute Publications, P.O.Box 4852, Hampden Station, Baltimore, Maryland 21211, USA.
Abstract by S.B. Westley

932 91 - 7/68

Agroforestry
Review, study, book, eucalyptus, ecological effects, water cycle, climate, erosion control, nutrients, soil fertility, social considerations, FAO

POORE, M.E.D. and C. FRIES

The ecological effects of eucalyptus.

FAO Forestry Paper 59,FAO, ISBN 92-5-102286-0, 1988, 55 pp.

The aim of this study is to provide a dispassionate survey of the available information on the ecological effects of eucalypts. It is hoped that this will be of value to those who are concerned in evaluating alternatives for development and land use, to the managers of forest and agricultural land, and to the interested public. It is hoped, too, that by dispelling some of the misunderstanding surrounding this subject, it will lead to better decisions about land use and to decisions that are more widely acceptable.
The question of *Eucalyptus* plantations is one that arouses strong feelings, both for and against; and the arguments used by both the opponents and the supporters of eucalypts have often been based more on prejudice than on a balanced consideration of the facts.
The genus has been a popular choice for introduction, especially in the warmer parts of the world, because of its rapid growth and the wide range of conditions in which the various species can grow. On the other hand these plantations have been strongly criticised because they are alleged to cause adverse effects on soil (impoverishment and encouraging erosion), on hydrology (by drying up aquifers) and because they provide a relatively poor habitat for wildlife.
Currently, world forests are being cut at many times the rate at which they are being replaced.
To cope with this situation, option is often taken to plant fast-growing, highly utilizable, exotic tree species. One such exotic group is found in the more than 600 species of the genus *Eucalyptus*, whose popularity as plantation species is attributable to their being generally very adaptable, fast growing and with a wide range of utility from sawn wood and processed wood products to high calorific value fuelwood as well as a variety of environmental and ornamental uses. Such popularity may be judged by the more than 80 countries that have shown an interest in eucalypts and have planted more than 4 million hectares world-wide outside the natural range of Australia, S.E. Asia and the Pacific.
An annotated bibliography is included with the study. Each reference is classified according to subject and an indication is given of the usefulness of the particular paper to the subject of this review. It should be appreciated that not all references dealing with the cultivation of eucalypts are included, but only those that have some relevance to ecological effects. Also, many

of the studies were designed to tackle other problems and the 'relevance classification' does not necessarily reflect the quality of the paper.
The study is limited to those subjects and regions for which published information is available. In fact the majority of the work carried out has been in few countries, principally Australia, Brazil, some Mediterranean countries and India. Almost all of it refers to plantations in blocks; there is little about row plantings, shelter-belts or agroforestry.
This review concentrates on the effects on physical and biological features (on micro- and macroclimate, on soils, on water, on populations of wild animals and plants); it includes, too, substitution effects such as the reduction in area of other ecosystems that are replaced by eucalypts. It does not deal in detail with social and economic effects; though these are touched upon in Chapter V.
Many of the experiments described were conducted with a specific or limited purpose; the greatest caution must be taken in extrapolating their results to other circumstances. Conclusions about the hydrological effects of an experiment in an arid region are most unlikely to have much validity in an area with high rainfall.
Similarly many of the results refer only to a particular part of a wider ecological process. For example they may cover the effect of the foliage of a tree in intercepting rainfall. This measure only has significance if it is viewed in the context of the whole water cycle.
The mainbody of the report deals with ecological effects in four chapters: the first is concerned with eucalypts and water; the second with soil erosion; the third with soil fertility, and the fourth, how the planting of eucalypts interacts with other living organisms - the effects that eucalypts may have in competing with or displacing these. These chapters will be followed by a short discussion of some of the socio-economic implications of planting eucalypts. The review will end with a chapter summarising the main conclusions.