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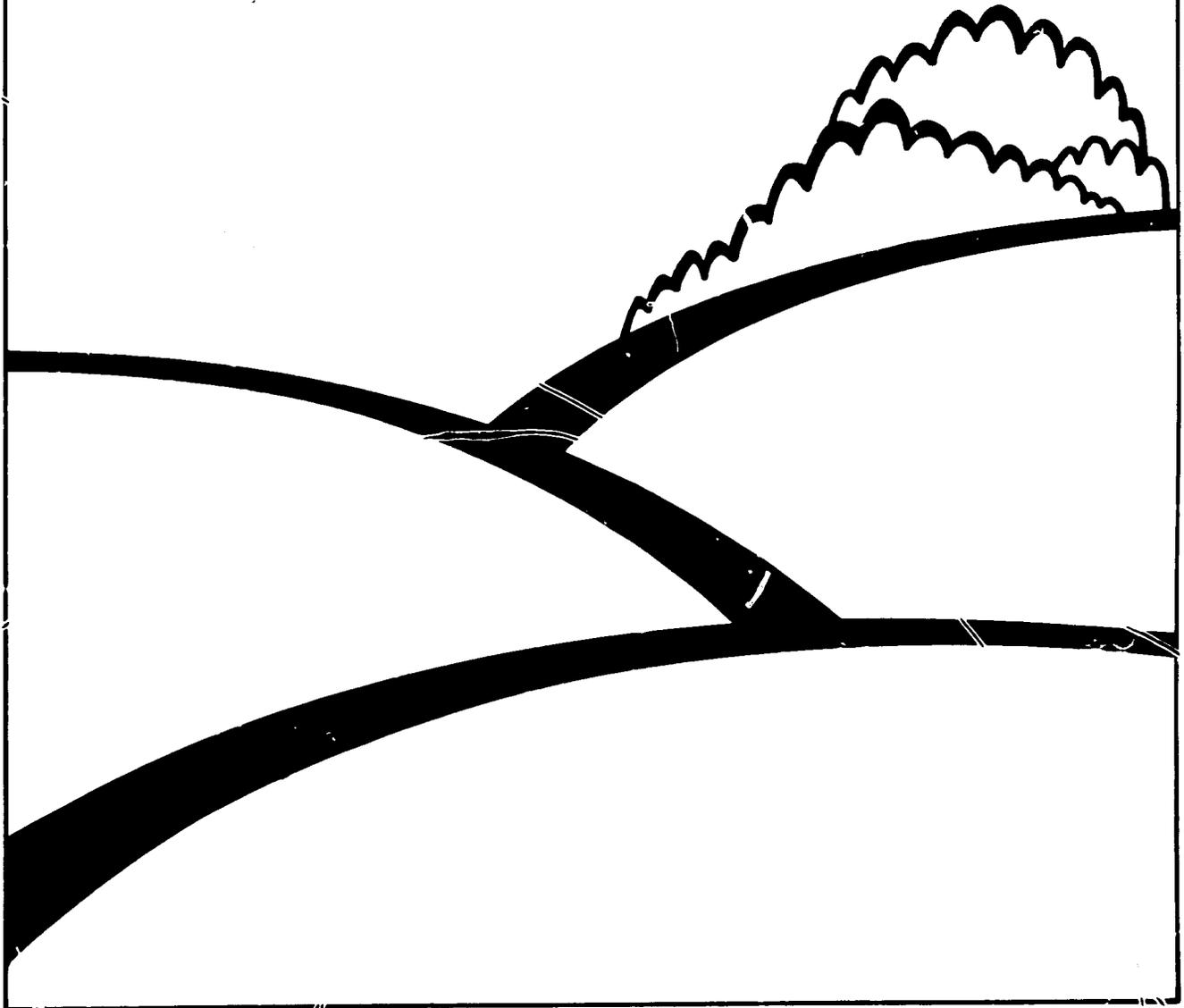
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# Abstracts

## International Hill Land Symposium

West Virginia University  
Morgantown, WV, USA  
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## **1 HILLS AND UPLANDS IN BRITAIN – THE LIMITATIONS AND THE DEVELOPMENT OF POTENTIAL**

**Roy Hughes**

**Welsh Plant Breeding Station, Aberystwyth, Wales**

Inherent low natural productivity, and social and economic disadvantages provide little incentive for farmers to adopt technical advances. Despite resistance to investment in hill farming an R and D programme is essential to supply technology for future development. Within Europe, marked contrasts in the nature of constraints and levels of production exist between and within regions. Altitude is no criterion, similar problems prevailing at sea level (Scotland) and at 1000 m (Alps). In U.K. one-third of the agricultural area is devoted to hill farming based on sheep, supplemented to varying degrees by cattle. The saleable products are wool, and store and breeding livestock, low output generating insufficient profit to provide capital for improvements. Grants and subsidies often exceed net farm income. The first step in an R and D programme is to quantify the main barriers to production, climate, soil and vegetation. Weather changes rapidly with altitude in U.K., but physical data alone are insufficient, plant/weather responses giving a better integration of the interacting factors. Soil limitations are similar to other regions where the parent materials are ancient rocks. Low pH, high organic matter and low nutrient status must be evaluated on the basis of improvement requirements. Indigenous species are adapted to survival and are intrinsically poor in feed quality, a situation exacerbated by systems that allow the accumulation of mature herbage during the summer. Individual farms are a mosaic of soil/vegetation types, an important consideration in elucidating potential and development strategies. The primary objective is an overall improvement in animal nutrition to increase livestock output, and this is best achieved by hill land improvement. Farm ecograms can be constructed on the basis of detailed studies describing the agronomic implications of the manipulation of livestock and of vegetation by management with and without fertilizers, low-cost surface seeding and ploughing and reseeded. Government support policies should reflect the fact that viable farming is basic to multiple land use strategy.

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## **2 SITUATION AND TRENDS OF HILL LAND MANAGEMENT IN CENTRAL EUROPE**

**G. Voigtlander\* and G. Spatz**

**Lehrstuhl für Grünlandlehre der Technischen Universität München, Freising-Weihenstephan, Federal Republic of Germany**

Hill lands in Central Europe have been used agriculturally as far as possible up to present times. Large areas of little productivity were abandoned not before the last decade. At the same time the mountains became more and more important as recreation areas. But requirements of people are orientated to a type of landscape as it was formed by agriculture and forestry during centuries. Therefore most governments

**\*Author to present paper**

tend to maintain agriculture even if it is not economical. Also the public is prepared to support the agriculture of hill lands. But the load of the public budget is to be kept as small as possible. Therefore in order to keep the landscape open alternatives to agricultural utilization are tried, for instance mowing, application of herbicides and burning of dead plant residues. Furthermore abandoned areas which are not treated are observed and their impact on the vegetation, the ecology and the recreational function of the landscape are examined. The suitability of agricultural and non-agricultural procedures for conservation and securing all essential functions of the landscape are discussed. The expenses of different systems of farming, such as full-time-farming, part-time-farming and cooperative farming are compared.

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### **3 HILL LAND USE IN THE UNITED STATES**

**R. M. Davis**

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Like most other natural resources, hill land is in limited supply and will require good conservation planning if it is to realize its fullest potential. Planning should involve three steps: (1) identifying the most effective use for each tract--mining, cropping, pasture or grazing, wildlife, recreation, or forestry; (2) developing and using conservation techniques, such as minimum tillage, that will reduce erosion, sedimentation, and other conservation hazards; and (3) blending total hill land use with that of other available lands in the most efficient national mix.

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### **4 HILL COUNTRY FARMING IN NEW ZEALAND: AN OVERVIEW (See Appendix)**

**R. W. Brougham**

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### **5 LAND AND LIFE IN NEPAL HIMALAYA**

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Nepal occupies two third of the Himalaya Range, the youngest mountain in the world. This is a barrier between the cold Alpine to arctic climate in the north and the warm humid monsoonic climate in the south.

The Himalaya has been densely populated by varied ethnical groups with diversified occupations in terms of available cultivable land.

The farming has been mainly subsistence, composed chiefly of food grain cultivation and livestock--each complementing other. The trade between north and south of Nepal did help in the past to build up their economy. The hand-crafts have been supporting their need for cloths and other materials for packing, storage and other household needs.

With the increase in population the increase in demand for food, shelter, cloth and energy, the Himalaya has been exposed to the destruction of the forest and natural vegetations. This action has been more aggravated to the changes brought about by the nature. The eco-system has been disturbed unknowingly by the man. The human life in the Himalaya has been threatened.

This disturbed eco-system has been difficult to solve due to the rugged topographical condition, illiteracy to understand to keep up the eco-system, poor to invest for its improvement.

This creates a situation which demands the immediate attention of the developed world body to do at least something to maintain the life of the Himalayan people.

The attention should be geared up towards the study and research finding solution, mass education, and action to restore the eco-system for the sake of man.

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## **6 HILL LAND AGRICULTURE IN THE HUMID TROPICS**

**D. L. Plucknett**

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The Humid Tropics (HT) comprise a large proportion of the less-populated, less-developed lands of the earth. Hill lands make up a considerable part of the HT. Hill land use varies widely, including; shifting cultivation, subsistence farming, small to large scale grazing, and small to large scale plantation or cash cropping. Land use is strongly affected by factors such as population pressure, health factors, world markets for export crops, and land tenure patterns. HT hill lands are commonly used to produce export crops such as tea, coffee, bananas, pineapple, sugarcane, oil palm, Hevea rubber, cinchona, and valuable cultivated woods such as mahogany and teak. Food crops grown on small or subsistence farms include maize, beans, plantains, edible aroids, yams, cassava, and fruits such as avocado, mango, and papaya. These lands face serious problems including deforestation, declining soil productivity with continued cutting and burning in some shifting cultivation systems, increased land clearing and settlement by landless cultivators of persons fleeing disease-ridden lowlands, continued wood cutting for firewood or charcoal, or expanded land clearing for poor quality pastures. Land denudation, if continued and uncontrolled on steep slopes, often leads to land degradation through erosion, flooding, and results in damage to cultivated lands and more heavily populated areas in the lowlands. Improved watershed protection and management will be required in order to prevent further deterioration. Under good management HT hill lands can produce much-needed food and rural income, and constitute a valuable resource for many countries, because of generally favorable rainfall and equable year-round growing conditions. Strong efforts must be made to bring about better land use and management for these lands, in order to use them for the benefit of man while ensuring their future productivity.

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## **7 DEVELOPMENT AND USE OF HILL LANDS FOR INTENSIVE AGRICULTURE IN SRI LANKA**

**R. R. Appadurai**

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University of Sri Lanka, Peradeniya, Sri Lanka**

The use of hill lands for intensive agriculture in Sri Lanka dates back to the opening of the plantations nearly one and a half centuries ago, first for Coffee and later for Tea and Rubber, when more than 400,000 ha of jungle land were brought under plantation crops within a period of about 100 years. The spread of the plantation system with its emphasis on large scale cultivation, heavy use of capital and labour and producing primarily for export has been chiefly responsible for the hill country becoming the major contributor to national income. In recent years, however, world market trends, the advent of clones with high yield potential, the advance of technology, as well as serious soil erosion leading to degradation of Tea and Rubber lands particularly at elevations below 1200 m have pointed to the need for Sri Lanka to confine her plantations to the more favoured areas and diversify the marginal ones to other more profitable crops. Rapid increases in human population have also resulted in strong pressures on available land resources for the cultivation of food and cash crops. Land reform legislation enacted in 1972 and 1975 has further provided a unique opportunity to transform these hill lands to the best economic and social advantage. The Agricultural diversification project established in 1970 is engaged in a programme of land use adjustments on marginal plantations on hill lands. Based on land capability studies and land and site evaluations the project has used the catchment as its planning unit for Agricultural diversification. Settlement farming based on existing forest garden farms and new crop combinations such as coconut for intercropping with pasture, cacao, coffee, spice crops, fodder crops, sericulture and forest species are being introduced on an integrated development plan for the catchment as a whole. Next to the plantations, the natural grasslands of the hills, locally known as the 'patanas' constitute an important potential resource and are being developed for grassland farming as the climate of the hills is suitable for both livestock and pasture. The wet patanas have been successfully replaced by Kikuyu (Pennisetum clandestinum Hochst) a productive pasture, and the dry patanas after a period of pioneer cropping by improved species such as the Paspalums, Pannicums and Setarias. The aim is also to bring the forest areas of the catchments into a productive state to conserve the soil and water resources of the catchment and to provide timber pulpwood and fuel.

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## 8 INTENSIVE CROP AND ANIMAL PRODUCTION SYSTEMS IN THE TROPICAL HILL LAND OF PUERTO RICO

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Hundred of millions of acres of hill lands in the humid tropics have abundant, fairly well distributed rainfall, deep porous soils and year round growing weather. Population pressures frequently require intensive use of these lands for food production. Crops for these lands should be soil protective or capable of being managed in such a way that proper conservation of soil and water are assured. In Puerto Rico intensive grassland management techniques for hill lands have resulted in the production of over 1,000 pounds of gain in weight or 7,000 pounds of milk per acre yearly with cattle receiving no concentrate feed. Intensively cultivated plantains with minimum tillage and strip cropping have produced over 20 tons per acre yearly of high carbohydrate food with a caloric content equivalent to that in 150 bushels of corn. Intensively managed coffee has produced over 2,000 pounds of market coffee per acre yearly and papayas over 50 tons of fruit. Bananas grown under semi-forest conditions have produced over 15

tons of fruit per acre yearly and cocoyans over 12 tons of tuber per acre yearly on such lands,

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## 9 LAND USE IN HILL COUNTRY IN CENTRAL AMERICA

J. L. Walker

North Carolina State University, Raleigh, North Carolina, and Agency for International Development, Guatemala.

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## 10 FACTORS AFFECTING INCREASED AGRICULTURAL PRODUCTION FROM MARGINAL LAND IN EAST AFRICA

R. S. Musangi

University of Nairobi, Kabete, Kenya.

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## 11 BREEDING GRASSES AND LEGUMES FOR HILL ENVIRONMENTS

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Hill environments in the U.K. have features which are common to many other upland areas of the World. Salient among these are low temperatures, and low light intensities, extremes of wet and dry conditions, and the inherently low nutrient status of the soil. Thus emphasis has to be placed on breeding pasture plants with improved productivity under these stress conditions. Improved management seeks to ameliorate the environmental limitations and breeding aims must be closely associated with management objectives. Where grazing control is possible, there is a high potential for the use of introduced lowland species. These have an improved seasonal growth pattern and nutritive value, and selection continues for improved winter hardiness and more efficient utilization of the limited soil nutrients. The most promising species is perennial ryegrass (Lolium perenne) and the approach is to extend the general adaptability of existing varieties. This has the dual advantage of avoiding the increased costs in producing seed of special purpose varieties, and of building in a greater insurance against damage during occasional severe winters in the lowlands. Winter-hardy ryegrass hybrids (L. multiflorum x L. perenne) and ryegrass/fescue hybrids (Lolium x Festuca) offer new potentials as conservation crops on enclosed areas. For the more open hill areas, the selective improvement of indigenous species is also being examined, particularly forms of red fescue (F. rubra) which maintain higher nutritive value throughout the season. In these N-deficient soils, the establishment of a pasture legume is the cornerstone of improvement, and work is focussed on selecting white clover/Rhizobia associations which are tolerant of low temperatures and soil acidity and have an enhanced efficiency in nitrogen fixation over a longer period of the year.

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## 12 TECHNIQUES FOR HILL LAND IMPROVEMENT USED IN THE UNITED KINGDOM

P. Newbould

Hill Farming Research Organization, Penicuik, Midlothian, Scotland

Techniques used to improve hill land for agriculture in the UK are described. They range in cost, speed of response and degree and persistence of improvement, from the provision of a fence alone, enabling control of grazing, to the latter, plus full cultivation and the application of fertilisers and seeds. The choice of a specific technique depends primarily on the existing soil type and its associated plant community, on the requirements of the grazing system and on economic considerations. Physical features of the terrain, such as slope, degree of wetness, aspect and access are secondary factors which can modify the technique selected. The climate, physical and chemical characteristics of some of the main types of hill soils and the seasonal production patterns of the indigenous vegetation which determine the technique and especially the need for fertiliser, are discussed. The relative role and cost of nitrogen from fertiliser and from legumes and the responses of sown plants, especially white clover, to added lime, phosphate, potassium and trace elements in hill soils are described. Emphasis is laid on the need to define at the outset the use to which the improved pasture production will be put within the farming system, and on the importance of sound grazing management in the early years so as to influence the proportion of white clover and the performance of the sward. Also, the cost of utilising the extra pasture over and above the initial expense of land improvement must be taken into account. This includes, for example, the provision of water for stock, additional supplementary feed, increased use of preventive veterinary medicines and the application of maintenance dressings of fertiliser. The need for improved and cheaper fence designs, for plants better suited to hill environments, for more information on fertiliser responses and for machinery specially designed to clear existing vegetation and to cultivate and sow hill soils is discussed. In conclusion, the wider applicability of these principles and techniques to other hilly parts of the world is considered.

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## 13 HILL LAND IMPROVEMENT IN THE EASTERN UNITED STATES

R. W. Van Keuren

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The hill lands of eastern United States with a generally favorable climate supports a complex vegetation dominated by deciduous forests. The soils are equally complex with gray-brown podzolic, sols bruns acides, and red-yellow polzolics the most common groups. Lime and phosphorus are the major soil amendments needed. Earlier improvement techniques involved soil fertility improvement including amendments of lime, P, K, and N, introduction of more productive species, and better forage management. Reseeding is to legumes of Trifolium, Medicago, and Lotus spp. and cool season grasses (Bromus, Phleum, Dactylis, and Festuca spp.). Poa pratensis L. is a common invader, particularly in the northern regions and at higher elevations in more southern areas. Because of erosion hazards, recent emphasis has been on no-tillage techniques using herbicides for vegetation control, and sod-seeding to introduce legumes into grasses, primarily with ground equipment. Farms are generally small, limiting opportunities for large scale improvement techniques such as aerial applications. Utilization of forages for beef cattle and sheep has recently emphasized labor-saving systems, including year-around pastures with field stored hay and stock-piled forage.

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## **14 FACTORS AFFECTING PASTURE ESTABLISHMENT IN NON-CULTIVATED SEEDBEDS ON HILL COUNTRY IN TEMPERATE AND SUB-TROPICAL AUSTRALIA**

**F. G. Swain**

Hawkesbury Agricultural College, New South Wales, Australia

The present state of knowledge on factors affecting pasture establishment in non-cultivated seedbeds on hill country in temperate and sub-tropical Australia is reviewed.

Emphasis is placed on:

- (i) an examination of the role of aerial or surface sowing and sod-seeding techniques in pasture establishment on hill country;
- (ii) the effect of environmental factors;
- (iii) the relative importance of the various causes of loss of plants during germination, radical penetration, early establishment and survival over the first 12 months; and
- (iv) the potential for pasture improvement of hill country in temperate and sub-tropical Australia.

The paper refers to research studies undertaken by the author and also highlights principles enunciated through research undertaken and published by other workers in temperate and sub-tropical Australia.

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## **15 LEGUME BASED PASTURES ON TROPICAL HILL LANDS**

**C. R. Roberts, J. H. Williams and Sons Pty. Ltd.,**

Murwillumbah, New South Wales, Australia

Legume based pastures have been successfully established on hill lands in climates ranging from the humid subtropics of eastern Australia to the wet equatorial climate of Malaysia. The question of alternative uses is briefly discussed with particular reference to the difficulty of achieving a new ecological balance on old cultivated hill lands. Techniques for pasture establishment and management are described, including: Seed-bed preparation, with and without soil disturbance; sowing by hand, by surface machinery and from the air; pasture maintenance, including fertilization and weed control; and grazing management to maintain a stable balance between the grass and legume components of the pasture and for the control of some invading species.

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## **16 SOCIAL ASPECTS OF AGRICULTURAL ORGANIZATION IN VENEZUELA AND LUZON**

**M. L. Barnett**

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A comparative approach is developed to two highland communities engaged in subsistence agriculture. Potato production predominates in the Venezuelan Andes village: a wet rice-sweet potato complex is the cultural core of the Ibaloi village in Mountain Province, Luzon. The differential impact of external market forces on both farming systems is explored, with attention paid to

stability of social organization and patterns of community reactions to changing economic and social pressures in ecologically restricted environments.

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**17 ANDEAN CULTURE AND AGRICULTURE: PERSPECTIVES ON DEVELOPMENT**

**S. B. Brush**

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Highland peasants in Peru utilize an agricultural technology and economic organization successfully adapted to the rugged Andean environment. The steep environmental gradient of the Andes is complemented by a diversity of production zones, crops, crop varieties, and economic relationships to produce a stable but low-yielding subsistence system. This system is now under the pressures of rising expectations and growing population. An international development effort focused on the potato, the staple of the Andean peasant, seeks to introduce new high-yielding varieties and imported agro-chemical technology to traditional villages. Such development portends far-reaching change in peasant culture and has been resisted by some Peruvian peasants. As development proceeds, important lessons must be learned from traditional peasant culture and agriculture. These lessons are concerned with the nature of peasant adaptation to the Andean environment and with the economic relationships between traditional, self-sufficient villages and larger economic spheres. They will be examined with reference to the village of Uchucmarca in northern Peru.

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**18 SOCIAL ORGANIZATION OF PEASANT FARMING IN MOUNTAIN AREAS OF MEXICO**

**Marielle Martinez**

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(See Appendix)

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**19 SOCIOCULTURAL AND AGRICULTURAL ORGANIZATION IN HILL LANDS IN KENYA AND GUATEMALA**

**Susan W. Almy**

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Factors in the demographic history and present social organization of two populations one on the slopes of Mount Kenya and one in the Western Highlands of Guatemala, will be used to illustrate the interaction of socio-cultural and agricultural systems and the importance of this interaction for attempts to understand and redesign the latter. The Kenyan case will be emphasized, and factors covered will include the history of migration to or from other ecological zones, past and potential population expansion, community control over individual decisions and group actions, labor specialization and decision mechanisms, and receptivity to outside information.

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## CHANGES IN RURAL SOCIAL ORGANIZATION: A COMPARISON BETWEEN RURAL MOUNTAINOUS APPALACHIAN AND GREEK COMMUNITIES

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The purpose of this paper is to present an overview of the processes of rural social change and their relationship to hill farming based on a comparison between rural Appalachia (examined over a forty year period) and mountainous Greek villages (examined over a period of twenty years).

Two overall conclusions have been drawn: First, despite considerable differences in content, the essential forms of social transition are remarkably similar. Second, the major direction of change in social structure, in both Appalachia and mountainous Greece, is facilitation of integration of the rural population into the larger societal system. This integration has and still is taking place through rapid changes within and among the major rural social institutions. Changes are implemented through rapid processes of socioeconomic differentiation often involving specialization and centralization.

In both societies the central axis of incorporation of the rural population into the larger society have been aspects of the economic institution and in particular the increased expectations for higher income and level of living which are themes of the mass society culture. Over a time span of about ten to fifteen years, in both societies certain changes can be detected--the disappearance of subsistence farming, the separation of the social from the economic functions of the farm family, better roads in Appalachia and concentration in larger villages migration to the city, reduced emotional attachment to the land, less favorable attitudes toward rural living, and finally increase, often rapidly, of cattle production. In Appalachia, the latter has in large part been implemented through part-time farming, and in Greece, through grazing on unconsolidated lands belonging to absentee owners. In general, the part-time Appalachian farmers' involvement and interest in hill farming, and use of the extension service is in large part determined by personal beliefs and disbeliefs, opportunities, local reference groups, and the way the individual relates himself to the larger society.

## PASTURE ESTABLISHMENT ON UNPLOUGHED HILL LAND IN NEW SOUTH WALES, AUSTRALIA.

M. H. Campbell

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Research in New South Wales, Australia has shown that inferior pastures can be replaced on unploughed hill land by surface-sown Medicago sativa, Trifolium subterraneum, Vicia dasycarpa, Lolium perenne, Lactylis glomerata, Phalaris tuberosa and Festuca arundinacea. Pastures dominated by Hypericum perforatum, Nassella trichotoma, nitrophilous annual weeds (Silybum marianum, Carlaminus lanatus, Hordeum leporinum, Bromus spp. etc) or low producing native grasses (Bothriochloa ambigua etc.) have been improved. Herbicides (dalapon, 2,4-D, amitrole or glyphosate) were necessary to kill inferior plants and allow establishment of perennial species. Herbicides were not necessary for the establishment of the annuals T. subterraneum and V. dasycarpa or the perennial T. repens. It was demonstrated that glyphosate had a deleterious effect on establishing legumes. The best time for herbicide application depended upon susceptibility of resident

species, time of germination of annuals as promoted by the autumn break, residual herbicide effects and optimum sowing time. Establishment was most reliable when seed treated with dieldrin to reduce ant theft was sown in late autumn. Accurate placement of herbicide, seed and fertilizer was obtained by aerial application under favourable climatic conditions. Lenient grazing after sowing, especially in dry periods, was essential for establishment and persistence of sown species. Plant density in established swards was increased by up to 1200 per cent by strategic grazing applied after the improved species had completed seeding. Production of native perennial grass pastures was increased from 500 kg/ha/year to 10,000 kg/ha/year over a four year period by the establishment of improved species.

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## 22 MINIMUM TILLAGE ESTABLISHMENT OF FIVE FORAGE SPECIES USING FIVE SOD-SEEDING UNITS AND TWO HERBICIDES

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Five forage species were sod-seeded into a Kentucky bluegrass (*Poa pratensis*) - timothy (*Phleum pratensis*) sod comparing five different soil tillage and seeding units and two herbicides in three separate studies. The experimental site was located on a Chillum silt loam with a pH of 6.5 and medium levels of both P and K. In Experiment I, the "John Deere Grassland Drill" modified to remove a 10-cm wide band of sod ahead of each seeded row was compared with (1) a straight colter-spear seeder, (2) a wide flute colter-double disc seeder, (3) a narrow flute colter-double disc seeder, (4) a deep ripple colter-double disc seeder, and (5) a wide flute colter with seed dropped just ahead of presswheel. Paraquat (0.56 Kg/ha) and Glyphosate (1.68 Kg/ha) were applied in a 10-cm band over the row at seeding in 1 through 5 for comparison. Species seeded were crownvetch (*Cornellia varia*), birdsfoot trefoil (*Lotus corniculatus*) and red clover (*Trifolium pratense*). In Experiment II these same legumes were sod-seeded using the wide flute colter-double disc seeder where Paraquat was applied in a 10-cm band over the row at 0.28 Kg, 0.56 Kg, and 1.12 Kg/ha. In Experiment III, the wide flute colter-double disc seeder was compared to the "Zip" sod seeder. Paraquat (0.56 Kg/ha) and Glyphosate (1.68 Kg/ha) were applied in 10-cm bands over the seeded row and broadcast over the entire plot. Forage species seeded were red clover, trefoil, crownvetch, alfalfa (*Medicago sativa*), and tall fescue (*Festuca arundinacea*). More complete sod control was obtained with Glyphosate than with paraquat but control was adequate for both herbicides. During the first year band herbicide application resulted in fewer weeds. Herbicides were more effective than removing the 10-cm strip of sod in terms of seedling establishment, forage yields, and leaving the pasture less susceptible to erosion. The wide flute colter-double disc combination resulted in better stands and higher forage yields the first year. Satisfactory stands and forage yields were obtained with the "Zip" seeder. Stands of red clover thinned significantly during the second year while stands of trefoil, tall fescue and especially crownvetch continued to increase each year.

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\*Author to present paper

## 23 PASTURE RENOVATION WITH ALTERNATE ROW SOD-SEEDING OF DIFFERENT LEGUME SPECIES

A. M. Decker, J. H. Vandersall, and N. A. Clark\*  
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A pasture, heavily infested with herbaceous weeds and woody species, was clipped twice with a heavy-duty brush hog during the summer of 1974. It was necessary to remove a few large trees and shrubs by hand. In early September accumulated trash and vegetative regrowth was removed with a flail harvester. The area was then divided into 20 0.607 hectare paddocks; these were grouped into sets of three (pasture grazing cycle) according to vegetative cover and field condition. Pasture treatments were assigned at random within each uniform set of paddocks group. Three of these sets were included in each of two replications, and pastures were grazed in a 3-pasture rotational system. Pasture treatments were: (1) brush and weed removal only, (2) alternate row sod-seeding of Trifolium pratense and T. repens with Cornella varia, (3) alternate row sod-seeding of Trifolium pratense and T. repens with Medicago sativa. Pastures were grazed from June through September, 1975. Two dairy heifers and two dairy steers were used as testers on each pasture treatment; additional steers were employed in the put-and-take system to maintain uniform pasture utilization. Pasture carrying capacity, daily animal gains, gains per hectare, and animal condition at the end of the grazing season were significantly increased with sod-seeded legumes. The weed population was substantially reduced by sod-seeding. Complete data for 1975 will be discussed along with preliminary results from the second grazing season which got underway April 15, 1976.

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## 24 HERBAGE VARIETY EVALUATION UNDER HILL AND UPLAND CONDITIONS IN WALES

J.M.M. Munro  
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Further increase in sheep and beef output from the hills and upland in Wales is dependent on a) more intensive management of existing drier reseeded areas and b) the improvement of a proportion of the remaining 0.6m ha of high acid wet organic and extremely N deficient native grasslands dominated by Molinia, Nardus, Eriophorum, Sphagnum and Festuca spp. Evaluation of grass and clover involves 3 stages: a) preliminary screening of a wide range of species and commercial varieties with emphasis on establishment vigour, winter-hardiness and growth rhythm b) consistency of yield over a period of years and range of soils and c) nutritive quality, measured initially by analysis of digestibility in vitro, water soluble carbohydrates, protein and minerals and subsequently by grazing trials where intake and liveweight gain is measured. Only a very limited range of species, including Trifolium repens, Festuca rubra, Lolium perenne and Phleum pratense is of value in the more extreme hill situations but removal of early spring grazing pressure on better land will allow the exploitation of Lolium hybrids and Trifolium pratense.

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## 25 HILL PASTURE IMPROVEMENT IN GALICIA

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The main characteristics of Galicia country (with an area of 2.9 million has. in the NW of Spain) are briefly presented. Later, it is referred the importance and the traditional use of the hill country as well as the new requirements for this land in a developing agriculture. In an unimproved stage hill country is mostly occupied by scrub (gorse and heather species) together with some rough grasses. A first classification of hill areas according to climate, soil and vegetation has been set up leading to 5 main areas. Field trials are being laid down in each of them to measure the main variables in pasture establishment: primary response to major nutrients N, P, K and Ca, time of sowing, mixtures of species and methods of land reclamation. Land development with cultivation. Good pasture establishment has been achieved in straight reclamation from scrub, although the use of pioneer crops and fallow have some advantages in land preparation and scrub weed control. From field trials in two of the main areas, fertilization appears as critical at establishment. P is highly responsive up to levels of 1 Tn superphosphate/ha, medium amounts of limestone (3 Tn/ha) are critical for good clover establishment, there is a moderate response to small levels of K (60 kg K<sub>2</sub>O/ha). In three of the main areas production during the first year ranged from 3.6 to 5.6 Tn DM/ha for a mixture of perennial ryegrass/cocksfoot/white clover. Minimum tillage gets productions of 3.0-3.5 Tn DM/ha for the first year. Land development without cultivation. Both adequate burning and sowing time are critical for a satisfactory establishment of the oversown seeds. Pasture management during the first years is also critical to improve the pasture and to avoid scrub reinvasion from both regrowth and seedlings. Short rotations with sheep during the first year eliminated or adequately controlled 85% of the gorse regrowth from stumps. First year production for 5 mixtures in oversowing ranged from 2.0 to 2.5 Tn DM/ha (20-35% being contributed by sown species).

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## 26 DEVELOPMENT AND PRODUCTIVITY OF OVERSEEDED PASTURES ON HILL COUNTRY IN NORTHERN NEW SOUTH WALES, AUSTRALIA.

P. M. Dowling

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Hill land of south eastern Australia receiving in excess of 635 mm annual precipitation is ideally suited to pasture development by aerial techniques. Legumes are a vital part of such development and in northern New South Wales, little difficulty has been experienced in introducing the main legume, Trifolium repens. However marked changes in botanical composition due to T. repens dominance have resulted in bloating losses with cattle. Introduction of perennial grasses such as Phalaris aquatica and Festuca arundinacea tends to limit legume dominance and provide long term sward stability. In contrast to T. repens, establishment of these grass species when seeded aerially has largely been unsuccessful. To overcome pro-

blems of poor establishment by perennial grass species, factors including seed coatings, vegetative cover, herbicides, and seeding and fertilizer rates were evaluated at Glen Innes, New South Wales. Seed coatings had a negligible influence on establishment, whereas the effect of vegetative cover and herbicide was highly beneficial. Heavier seeding rates could also be substituted for prior herbicide application. Resultant pasture composition and seeding success was markedly influenced by variable seeding and fertilizer rates. From a series of monthly seedings and predicted soil moisture, the probability of establishment in any month of the year was ascertained and the optimal seeding time determined. But the best developmental technique may not necessarily result in the maximum return per dollar invested. In a large scale field experiment, gross margin analyses of different stocking rates were compared for three levels of pasture development. These were: fertilizer only; fertilizer plus grass seed; fertilizer plus grass seed plus prior herbicide application. Data for the first three years show that botanical composition, pasture production, sheep liveweight and wool growth are significantly affected by level of pasture development. So far however, gross margins tend to favour the least costly method of pasture development. Although expensive and long term, such research is required if the maximum benefit of a superior technique is to gain acceptance by landowners.

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## 27 AERIAL APPLICATION OF HERBICIDES, SEED AND FERTILIZER IMPROVES FORAGE ON HILL LAND

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The Ozark Highland area of Missouri, Arkansas and Oklahoma is in a transition zone between woodland and prairie. White oak (Quercus alba L.), black oak (Q. velutina Lam.), post oak (Q. stellata Wagnh.), black-jack oak (Q. marilandica Muenchh.) and various hickories (Carya spp.) are the major woody species. Much of the woodland that was logged in the past is used for grazing along with the prairie sites. Woody species regenerate after logging of the forest sites and also invade prairie areas. Competition from woody species cause severe reductions in forage production. In the past, cattlemen have attempted to control woody species by cutting, grubbing, girdling, burning, chaining, and bulldozing. Most of these methods are difficult, expensive and often open the soil to serious erosion. Steep slopes and rocky terrain add to the problem. On many sites, forage species are sparse and revegetation is slow. Also, soils are frequently low in fertility. Aerial applications of herbicides in late May or early June have provided an economical means of reducing woody growth. Aerial seeding of tall fescue (Festuca arundinacea Schreb.) or orchardgrass (Dactylis glomerata L.) on sprayed areas has dramatically increased forage production. Burning the leaf litter before seeding is necessary so that the seedlings become established in the ashes. Aerial applications of fertilizer on the rough terrain is becoming a standard practice. Aerial applications of lime, because of the bulk involved, has not been practical.

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## 28 PRODUCTION AND SPECIES COMPOSITION OF HILL PASTURES AS INFLUENCED BY LIME AND FERTILIZER.

B. S. Baker

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Several permanent pasture sites representing different soils, exposures, and climatic conditions were treated with lime, phosphate, and potash according to standard West Virginia University-Soil Test Laboratory recommendations for permanent pastures. No nitrogen was applied at any of the sites. Pasture cages were used to protect the areas from grazing animals. The forage was harvested when it reached a height of 10 to 20 centimeters. Some sites which produced 1120 kilograms (kg)/hectare (ha) in 1971 produced over 4500 kg of forage per year from 1972 to 1975 with the application of lime and phosphate. When treated according to recommendations, forage yields for the five years have averaged between 2800 and 3300 kg/ha of dry matter. When treated, the legume content has varied from near zero to slightly over 40 percent of the dry weight. Some sites have exhibited rapid increases in yield with treatment and other sites have shown little response to treatment. In nearly all cases the increases in yield have been accompanied by increases in legume content of the sward.

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## 29 EFFECT OF PHOSPHORUS, SULFUR AND MOLYBDENUM ON SUBCLOVER-GRASS HILL PASTURE YIELDS IN SOUTHEASTERN OREGON, U.S.A.

L. Cannon

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The 81,000 hectares of hill land in southwestern Oregon used for cattle and sheep grazing is ideal for subclover and grass pastures. The area averages 127 centimeters of rainfall from October to June with less than 12 centimeters of rainfall during the remainder of the year. Winter temperatures are seldom below 4°C and some pasture growth is received during the winter months. Subclover-grass pastures on hill land in this area are capable of greatly increased yields if the nutrient deficiencies of the soil are corrected. Fertilizer trials to investigate soil deficiencies were conducted on hill pastures at seven different locations from 1965 to 1975. The need for phosphorus, sulfur and molybdenum fertilizer on subclover-grass pastures was investigated in these trials. Yields were increased from 80 to 230 percent from the application of 22 kilograms phosphorus per hectare, 25 kilograms sulfur per hectare, and 420 grams molybdenum per hectare. Yields were increased 3400 kilograms of airdry forage per hectare at one site with the average increases at the seven sites 2,573 kilograms airdry forage per hectare. The application of 420 grams molybdenum per hectare increased yields from 21 to 190 percent over treatments receiving phosphorus and sulfur but not the molybdenum. The application of phosphorus, sulfur and molybdenum fertilizers become a regular practice of hill land ranchers in southwestern Oregon since 1971 as a result of this and related work.

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## 30 LIME AND PHOSPHORUS RESPONSE OF MEDICAGO SATIVA SEEDLINGS ON LOW pH HILL-LAND SOILS

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\*Author to present paper

Greenhouse and field studies were conducted to evaluate the response of alfalfa (*Medicago sativa* L.) seedlings on low pH and low fertility hill land soils of Southeastern Ohio. Treatment variables included lime coated seed and phosphorus rates and sources. The use of rock phosphate, as a source of phosphorus in soils not previously limed, was more advantageous than triple superphosphate (0-46-0) in initial seedling establishment and growth. Banding small quantities of limestone with the seed can be beneficial for improving initial seedling establishment on moderately acid soils but is not a satisfactory substitute for the rates recommended to correct soil reaction. Lime coated seeds may be beneficial for initial establishment but the benefits were rather temporary and not a satisfactory substitute for liming at rates necessary to correct soil reaction.

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**31**

### **THE CHALLENGE AND THREAT OF TOURISM AMONG THE EASTERN CHEROKEES**

**L. French**

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The Eastern Cherokees have played a crucial role in the development and success of the Great Smokey Mountain National Park. This success is so profound that the Eastern Cherokees are today the most visited American Indian group in the United States with over 8,000,000 tourists visiting the Qualla Boundary each tourist season (April - October). Yet this success has proved to be a paradoxical phenomenon for these Appalachian Indians. New and increased social problems now plague the Cherokees. This paper explores the pros and cons of the tourist industry in Southern Appalachia especially its economic and social-cultural effects as well as comments concerning future trends and viable alternatives.

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**32**

### **DEVELOPMENT CONTROL IN HILL LANDS**

**R. L. Keber**

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Planning for the physical environment of hill lands requires the use of site analysis and environmental design techniques that are not simple translations of level ground methodologies. This truism often is not reflected in legal tools intended to guide development of hill lands. Using a case study of the Southern Appalachians, the legal means of development control including subdivision regulations, zoning, floodplain regulations, and sedimentation abatement ordinances are critically reviewed and assessed. Recommendations for policies and programs which will effectively guide development and which are viable in a mountainous context are made.

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### **33 AGRICULTURAL VARIETIES AND ECO-ZONE SPECIALIZATION IN THE PERUVIAN ANDES**

**W. P. Mitchell**

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Altitude is a major determinant of plant growth in the Peruvian Andes. Altitude determines the amount of moisture, sunshine and temperature available to crops as well as natural vegetation. Consequently, major eco-zones are found within very short distances on mountain slopes. The people of the Andes adapt to these vertical eco-zones by the use of different crops, as well as different varieties of the same crop, in differing eco-zones.

This paper explores the agricultural adaptation to the vertical eco-zones of Quinoa, a community in the central Peruvian Andes. In addition to exploring the varieties of crops grown in each eco-zone, the paper examines the patterns of land tenure and economic exchange by means of which the different eco-zones are integrated into a single economy.

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### **34 SOCIO-ECOLOGICAL EVOLUTION IN THE HILL COUNTRY OF SOUTHWESTERN WEST VIRGINIA**

**R. L. Smith**

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This paper reviews the impact of man on the forest ecosystem of the hill country of southwestern West Virginia and the impact of that environment on man. The rugged low hill country of Appalachia was settled shortly after the American revolution. Changes in travel routes and the availability of land to the north, south, and west left the people isolated until the late 1800's and early 1900's and allowed the development of a unique hill culture. The settlers were not agriculturally inclined, knew little about growing crops, and practiced essentially a swidden form of agriculture. The region has gone through five development stages each with its own cultural and ecological and demographic characteristics. 1) Subsistence hunting that supported a low human population and deleted the region of its game. 2) Patch agriculture that supported a rapidly growing population and a barter economy, caused rapid depletion of lowland soils, and forced more and more of the population onto steep hillsides and into remote hollows. 3) Timber harvesting stage which involved the invasion of the region by the eastern financial establishment, provided part time employment, introduced a cash economy, and depleted the timber resources. 4) Coal mining stage which quickly followed the timber harvesting stage. It brought in the railroads, settlements laws and courts and immigrants, imposed a foreign social culture onto a traditional mountain culture, stimulated a logistic population growth, and caused a rapid deterioration of the region. 5) Surface mining stage which has resulted in the ultimate destruction of the mountain ecosystems as they have existed. What the social cultural and ecological outlook for the future is the subject of some speculation.

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### **35 PAST AND PRESENT IN THE SWISS ALPS**

**Ellen Wiegandt**

University of Michigan and Geneva, Switzerland

In considering present and future problems of hill agriculture and the policies being devised to deal with them, it is expedient to examine the ways in which relationships were shaped by a region's particular past. An historical perspective provides insight into the development and function of deeply rooted practices which may appear maladapted in today's context. The Swiss Alpine area is well suited to an examination of these issues because it has characteristics derived from an autonomous, decentralized political past combined with present federal concern with Swiss agricultural self sufficiency. The various communal institutions and their interrelationships are analyzed with respect to the way they organized the distribution of resources among domestic groups. Emphasis is placed on the system of partible inheritance which historically had an ecological function--to give the whole population access to different types and qualities of land, and a socio-economic function--to supply each household in each generation with a resource base. The problems that exist today because of the extreme fragmentation of land resulting from this pattern of inheritance rules is then discussed. Agriculture is seen by the Swiss government as a vital national resource and there is a strong commitment to support it, especially in marginal areas. To do so it is felt that profound changes must be made in basic ecological and cultural arrangements. Policies the government has tried to implement in the Alpine region are presented with an evaluation of their positive and negative aspects.

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## **36 THE TRAGEDY OF THE COMMONS REVISITED: LAND USE AND ENVIRONMENTAL QUALITY IN HIGH-ALTITUDE ANDEAN GRASSLANDS**

**B. S. Orlove**

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In his famous paper, "The Tragedy of the Commons", Hardin suggests that collectively-held pastures are a paradigm case of the conflict between public and individual interest, since greed will direct individuals to crowd too many animals onto pasture, leading to the degradation of a public resource. Field data from southern highland Peru directly contradicts this hypothesis. Much pasture land is communally held, herd animals (sheep, cattle, llamas and alpacas) are individually owned, and there is no regulation of land use by the central government. Despite these conditions, and the delicate nature of the grassland ecosystems located above 3500 meters in elevation, there is little or no environmental degradation. This paper investigates the interrelations of biological, social and cultural variables influencing land use in this area. It briefly describes the edaphic, climatic and hydrographic conditions of the mountain grassland ecosystem. The transhumance cycle and the settlement patterns of the Quechua-speaking Indian herders are examined. Socio-cultural responses to density-independent factors (drought, excessive frost) and to density-dependent factors (increased herd population size per unit area) trigger increased slaughter of animals, leading animal populations to remain below the carrying capacity of the grasslands. These responses are shown to be the conscious rational responses of individual herders, rather than an automatic product of a traditional culture. It is argued that changing the community-based social organization of these herders and altering the system of economic incentives under which they operate would lead to environmental degradation rather than long-term increases in wool and meat yields, as economic development experts have argued. Policy implications are drawn. Comparisons with high-altitude herders in the Alps and the Himalayas, where environmental, economic and political conditions are somewhat different, are briefly explored.

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## **37 COMBATTING FORAGE ABUSES AND SOCIAL PROBLEMS FOR ATLAS MOUNTAIN BERBERS**

**J. M. Teitelbaum**

**University of North Carolina, Chapel Hill, North Carolina, USA.**

Forage crops have become key to commercial sheep-raising among Atlas Mountain Berbers of Morocco, but misuse of the fragile hill soils leads to erosion as well as tribal atrophy. Thousands of Berber-speaking pastoralists raise sheep and goats in the harsh alpine and semi-desert environment of the Upper Moulouya river valley at altitudes of three thousand to six thousand feet. Traditionally they practiced nomadic transhumance on the collective tribal grazing lands of sagebrush and perennialgrasses. However, the pastoral ecosystem has been severely disrupted by overstocking animals on the ranges and growing feedgrain crops on deforested hillsides. Despite high mortality, enough lambs survive to provide marketable offtake for the Arab urban centers of Morocco where meat is in heavy demand. This transformation of subsistence nomads into a cash economy based on livestock and feedgrains has set the scene for an ecological and economic tragedy in case of prolonged drought or flood. Alienation of the tribal "commons" by large private landholders and livestockmen has disintegrated the egalitarian patrilineal tribal system and forced nomads to settle in riveraine villages. Breakdown of tribal values has resulted in many poor landless laborers, a high rate of divorce, female prostitution and illegitimacy, and malnutrition-especially among vulnerable children. To correct abuses of the land requires an integrated plan to cull overstocked flocks, reduce lamb mortality rates, revegetate ruined pastures and reforest and conserve hillsides. Simultaneously, landless herders and small farmers who depend on large landowners and livestockmen for a living will need training in hill land cultivation and livestock management. This will require a new rural development institution whose mission combines agricultural conservation and animal production skills with sensitivity to tribal values and human needs in order to rehabilitate the regional ecology, economy and society of the Inter-Atlas Berbers.

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## **38 THE EVOLUTION OF COUNTRY PLANNING AS AN ALTERNATIVE TO URBAN PLANNING FOR RURAL AREAS**

**W. P. Dinsmoor White**

**Piedmont Environmental Council, Warrenton, Virginia, USA**

A discussion of the efforts of a non-governmental agency to develop a relevant and workable system of planning for the use of land in a foothill region of Virginia, close to a rapidly-expanding metropolitan area. Three areas of concern are central to the issue: the conservation of productive and semi-productive farmland, the preservation of recreational and scenic open space, and the improvement of rural villages and towns as human habitats. The benefits arising from a new land use planning approach based upon these concerns are seen as a means to improving living quality, social community, and economic activity in rural areas in most parts of the U.S.A. Land Use restrictions are being developed through a variety of techniques to attain a more appropriate pattern of economic and social growth in rural areas.

The discussion is illustrated extensively with slides.

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**NUTE RIDGE, HALF A CENTURY LATER****S. B. Weeks****Institute of Natural and Environmental Resources, University of New Hampshire, Durham, New Hampshire, USA**

In 1926 Dr. Harry Woodworth, Agricultural Economist at the University of New Hampshire, in A Study of Nute Ridge - A Back Country Community, said:

"This ridge gives one the impression of a once prosperous farming community which has been slipping back for some time, and yet its location...and seeming good field land make it difficult to understand why it should not be as prosperous as similar communities in other parts of the state."

He then inventoried the Ridge's human, physical and economic assets; and offered a series of propositions concerning its future.

Nute Ridge is typical of much Northern New England hill country. In 1967 we appraised some of the adjustments that had occurred to that point; and we are today (1976) taking a further look, a point in time which spans half a century.

Adjustments on the Ridge since 1926 presented an interesting combination of certain static social characteristics intertwined with a slowly changing land use pattern and an infusion of "summer people." Today our initial evaluation suggests that the dynamics of the past ten years exceed those of the preceding forty. From these changes we extrapolate several propositions we believe will enhance renewed vitality in hill land sectors, including potential for "small agriculture" and other natural resource based enterprises.

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**HILL FARMING IN RELATION TO FUTURE FOOD POLICIES****H. F. Breimyer****University of Missouri, Columbia, Missouri, USA**

Attitudes toward hill farming in the United States have evolved historically from a preference for high if not sloped land in order to avoid malaria, to a kind of topographical snobbery in which level land was regarded as high class and hill land as low. Adaptability of level terrain to big equipment, and a confidence that the latest technology on level land would yield not only enough food but an embarrassing surplus, led to downgrading the role of hill country.

Events of the 1970s have jarred past confidence. They demonstrate not that food shortage is certain, but that food abundance is uncertain. Policy for food and agriculture in the future must protect against scarcity as a contingency. Moreover, technological trends that had relegated hill farming to subordinate status are being reversed slowly, as costs rise for industrial inputs, particularly energy and the metals.

Policy for hill farming will share in general farm and food policy but it will have its special features too. In some respects hill lands available to agriculture are more diverse, more heterogeneous, than level lands. They are subject to marginal competition not only with level land culture but with forests, recreation, mining, and other uses. Although United States policy has been careless with regard to protecting even its level farmlands, it has been still more indifferent toward hill lands. If we are to reverse this course and protect hill lands, guiding them into socially best use, it will be necessary to design acquisition, tax, and similar economic policies to that end.

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## **41 ECONOMICS OF APPALACHIAN AGRICULTURE**

**J. E. Martin**

University of Arkansas, Fayetteville, Arkansas, USA.

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## **42 ECONOMICS OF HILL FARMING IN THE UNITED KINGDOM AND WESTERN EUROPE**

**J. Pearce**

University of Reading, Reading, England

Hill Farming in the United Kingdom - the place of hill farming in the agricultural economy, physical constraints on the choice of system of farming and the levels of production achieved. Structural problems and policies for improving the structure and raising incomes. The main systems of hill farming are described showing the influence of size and indicating the importance of economies of scale, the proportion of enclosed land to open rough grazing and the effects of technical performance in enterprise input/output relationships. Examples are given of the economy of individual hill farms under different conditions, showing the levels of profitability achieved on a whole farm basis and the factors influencing success in the hill cattle and hill sheep enterprises. Support policy for hill farming is outlined and some indication is provided to show the returns to be expected from capital investment in improvements in forage and livestock outputs. The importance of socio-economic aspects affecting the future patterns of hill farming in the U.K. are described and references are made to the likely markets for hill farm products and the possibilities for developing additional sources of income.

Hill and Mountain Farming in Alpine Regions of Western Europe - the place of alpine farming in the agricultural economy is outlined, illustrating the constraints on choice of enterprises, systems of farming and the levels output obtained. The structure of alpine farming is described indicating the support policies aimed at structural improvement and the maintenance of incomes. Factors influencing the economy of the alpine farm are outlined showing the problems of marketing the products and achieving satisfactory returns from capital investments. Socio-economic aspects of alpine farming are illustrated, indicating the possibilities for structural improvement, raising incomes and relating the needs of the individual farm with the interests of the community at large.

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## **43 ECONOMIC ANALYSIS OF FOOD CROP PRODUCTION ON HILLSIDES—THE CARIBBEAN EXPERIENCE**

**L. B. Rankine**

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This study is concerned with an economic analysis of food crop production on Hillsides in the English-speaking countries of the Commonwealth Caribbean. It first traces the historical development of hillside production, identifies the major crops grown, their productivity levels, contributions to general economic development in terms of nutrition, employment, foreign exchange earnings and agro industrial linkage. Factors limiting production are identified and efforts to remove these constraints are reviewed. Conclusions

are drawn as to the lessons that might be learnt from these experiences.

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## **44 HILL LAND FARMING: AN INTERNATIONAL DIMENSION**

**W. C. Thiesenhusen**

**Land Tenure Center, University of Wisconsin, Madison, Wisconsin, USA**

Whether hillsides in less developed countries can be saved seems to depend as much on the will of the people to do so, on incentives and organization, on food to sustain the workers while they are engaged in conservation practices, and on wise technical help than on steepness of slope, amount of rainfall concentrated in a period of time, and population density. What is of prime importance for millions of the world's peasants--the bulk of those who are engaged in agriculture--is using what is now known about soil conservation. And what is now known will not be applied if the social, political, and economic organization is not propitious for the task. From this observation a few policy implications may be extrapolated: 1) If the legal framework were in place to assure a tenant who invests in terraces, contours, or forests that he could retain the land after certain minimal conservation standards were met (or at the very least that he could retain it for the number of years required to attain a respectable rate of return--which would probably have to be the lifetime of the cultivator), he might do so. 2) If hillside squatter's tenure rights could be made secure, as in a land reform, they might be more apt than otherwise to attempt conservation practices. 3) If hillside-farmer organizations could be set up, conservation and grass-roots leadership potential could be developed if incentives were provided. Of course governments will also have to be committed, for, at the very least, food and materials to feed workers while they are constructing terraces or planting trees must be provided. 4) If soil conservation techniques were made as important as seeds and fertilizer--that are often made available as part of the package of inputs that follow up a land reform--hill farms might be saved. 5) If zoning procedures could be set up so that industry and transportation systems would have to use the unproductive hillsides and the basins were reserved for agriculture several generations of time might be bought to allow for the rapid rate of population to be curtailed. This might be an especially useful technique in small countries like Taiwan. A certain amount of government intervention and even subsidy would be involved because this would raise short term establishment costs while providing long term benefits to the nation.

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## **45 CROP PRODUCTION ON HILL LANDS: HAS THE SMALL FARMER BEEN BYPASSED?**

**L. V. Crowder**

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Hill land agriculture occurs from sea level upward to the limits of plant growth imposed by low temperatures. Rainfall, degree of slope, and erodible soils impose constraints on crop production at all altitudes. At higher elevations ecosystems become more fragile and reduced temperatures, steeper slopes, varied microclimates, orientation of slopes to the sun and prevailing wind, restricted cropping systems, lack of animal power, shortage of animal feed and limited compost lead to reduced crop yields as compared to lower elevations. Isolation, inadequate transportation, restricted markets, and lack of services also contribute to subsistence farming.

Small holders at higher elevations tend to have the least income, least education, and least political power. Despite the ascribed characteristic of being "passive", however, they have generally developed traditional farming systems considered to be effective and efficient, given the limited resources under which they must operate. As a means of increasing crop production, grazing lands and forested areas have been brought under cultivation and cropping patterns intensified by some form of multiple cropping. At lower elevations more complex cropping patterns are encountered, frequently with 50 to 60 species found growing on a small farm. At higher elevations they are relatively simple with less than 20 species involved. A great majority of small holders have not benefited from the agricultural research of provincial, national and international institutes. Transfer of technology from the top down, i.e. demonstrations and scientist planned and conducted research, has not been effective, often attributed to the motivations, values and attitudes of subsistence farmers. It is possible, however, that technology is not geared toward their resources. A more appropriate approach might be that of establishing a base line which describes the small holder's present condition. Operational (on-the-farm) research could then be elaborated to involve him in the planning, executing, and evaluating. This would be complemented with more detailed tactical and strategic (supporting) research at comparable ecological sites (experimental stations).

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#### **46 THE STATUS OF CROP PRODUCTION ON HILL LANDS OF ETHIOPIA**

**Taye Bezuneh**

Debre Zeit Agricultural Experiment Station, Debre-Zeit, Ethiopia.

The topographic features of Ethiopia has diversified climatic zones suitable for the cultivation of different spp. of staple food crops. Elevation and temperature play descisive role in the range and optimum adaptation of various crops. For centuries, the mountain lands of Ethiopia have become the breeding grounds (through natural crossing and hybridization) for the apparent several land races of cereals, pulses and other important food crops. At the middle and high altitude regions of Ethiopia at least about 35% of crop production is on mountain lands. Characterstics of hill land farming particularly in central and northern highland regions of Ethiopia is production of miscellaneous crops with barley and tef (Eragrostis tef) as major crops. In this paper the crop production systems and problems associated with hill land utilization in various parts of Ethiopia are discussed.

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#### **47 CROP PRODUCTION SYSTEMS ON HILL LANDS IN THE CARIBBEAN**

**T. U. Ferguson**

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Crop production systems on hill-lands in the Caribbean can be divided into two broad groups thus: (1) those in which perennial tree crops are the main crops grown and (2) those in which short term or annual crops predominate. The main crops in the first group are citrus, nutmegs, cocoa and bananas. The production systems associated with these crops are generally of a high standard, the ground cover is generally good and soil erosion problems minimal. In the second group falls crop production systems associated with root crops (yams, sweet potatoes, white potatoes, cassava, aroids) corn, peas and beans, curcubits and other vegetable crops. In this group the soil may be bare for many months of the year and there is much soil disturbance. Soil erosion is a major problem. Production systems of this group and in particular those involving root crops are examined in detail.

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## **48 CROP PRODUCTION COMPLEXES IN HILL LANDS OF THE PHILIPPINES**

**R. L. Tinsley**

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The hill lands in the Philippines are those areas not normally suited for low-land paddy rice. The production complexes associated with the hill lands can be divided into those involving and not involving major capital inputs. Those without capital inputs are most frequently in highly remote areas without the essential infrastructure to move inputs in, or produce to market. These complexes are largely involved in shifting agriculture, or managing forest reserves, but also included the banawe rice terrace. The complexes with capital inputs are those that have infrastructure support including transportation and organized markets. They include both small farmers and large plantation. The small farmers are frequently involved in some very intensive cropping system including both subsistence and cash crops. They frequently use such intensive techniques as canopy stacking, intercropping and relay cropping. The large plantations are generally involved in monoculture of specific crop for which the plantation has developed the essential private support structure. Often these plantations are owned by large international companies or their Philippine subsidiaries.

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## **49 NEW SYSTEMS OF HILL FARMING IN SCOTLAND**

**J. B. McCreath**

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In any country the pattern of farming has been drawn by the skill and energy of successive generations responding to economic realities within the physical constraints of soil and climate. In hill country the degree of possible change is very much more limited by the rigidity of the physical framework than in lowland agriculture. In contrast, economic factors can and do fluctuate in the short term. The extensive traditional system characterised by low output and low cost has become, for many, one of low output and high cost. The response of producers to the pressure on profit margins has varied from tactical exercises to strategic reappraisal. The latter was only made possible as a result of the biological analyses by the Hill Farming Research Organisation (H.F.R.O.) of the fundamental aspects of hill sheep production. This work has culminated in a new system of handling hill flocks which gives

significantly higher output through increased ewe numbers and increased production per ewe. Although an important technical breakthrough, the financial implications have still to be ascertained over a wide spectrum of commercial farms. Such an investigation has recently been started by the three Scottish Colleges of Agriculture in consultation with H.F.R.O. In addition several enterprising flockmasters have been pioneering methods which involve considerable modification of the traditional system. The technical and economic constraints to be overcome, if the present system is to be replaced by a stable and more viable alternative, are considerable. The paper considers the various inter-dependent strands which must knit together if a new pattern of hill land utilization is to emerge and flourish.

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## **50 ECONOMICS OF HILL LAND UTILIZATION IN THAILAND**

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Total area of the country is about 51.4 million hectares in which 37 percent of total area of 19.2 million hectares are classified as hill land and mountain. Estimated 49 percent of hill land is presented in the North and the rest 51 percent is the sum of hill land in the other parts of country; Central, West, East and South where most of the land is utilized as national forest. So only the hill land area presented in the north has a potential to be used as agricultural land. But the land use pattern has usually been as shifting cultivation for several years by the hill tribe people. Now the Royal Thai government has concentrated on the agriculture practiced by the hill land people by changing their attitude of shifting cultivation and encouraging them to grow other economic crops instead of opium (UN/Thai Programme for Drug Abuse Control in Thailand). Thai government with the financial supported from United Nations Organization and United States Department of Agriculture has set projects for hill land agricultural development. Although the projects have no direct effect on the economics of the country but the government have to pay a considerable amount of money in each year for soil conservation, reforestation and watershed area improvement to prevent flooding and economic loss of low land agriculture. Besides the economic benefit gained from the development of hill land agriculture and utilizations the social and political problems should be directly solved.

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## **51 A METHOD FOR ANALYZING THE CONTRIBUTIONS OF FOREST-BASED ACTIVITY TO A REGION**

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Increasing emphasis is being placed upon planning for regional development in all types of economies. In heavily forested areas, forest-based activities are often a focus for analysis and planning for regional development. This paper rationalizes and articulates a method whereby the economic and related social contributions of forest-based or -oriented activities to a region may be analyzed in a comprehensive manner. The importance of such analysis to regional development problem analysis and planning is discussed. Findings based on application of the method in the Appalachian region of New York

State are summarized. Opportunities for further development and extension of the method are suggested, including application to activities other than those which are forest based.

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## 52 LAND USE PATTERNS IN APPALACHIA

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The Appalachia region consists of 397 counties stretching from Southern New York to Alabama and Georgia. The area is nearly all characterized by hilly to mountainous terrain, many small and part-time farms, timber and forestland, mineral (coal) resource exploitation and poverty. Until recently, at least, population was leaving the area, income increases lagged behind those of other areas of the nation, and there were high levels of unemployment. Large areas of timberland were cut over and despoiled - subsequently substantial areas were incorporated into national forests. However, very large areas were purchased and are still owned by lumber or paper firms, railroads, coal companies, and steel producers which operate as absentee land owners. The mechanization of agriculture made farming less competitive and subsequently large areas of land were left idle and reverted to bush or forests. The recent energy crisis has made coal an important commodity again and has improved the relative economic situation in Appalachia. In addition, many new roads have been constructed, low prices have attracted out-of-state land purchasers, and recreation activities have increased, which in conjunction with the urban crisis and the revival of mining, has led to a reversal in population trends and greatly increased demand for land in the whole region. While problems remain, it now appears that the disadvantaged status of the Appalachian region is gradually being resolved although land use activities remain as serious and unresolved problems.

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## 53 RAPID ADJUSTMENT FARMS, A METHOD TO DEMONSTRATE NEW CROP-LIVESTOCK TECHNOLOGY AND FARM MANAGEMENT IN OHIO'S APPALACHIAN COUNTIES

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In 1969, the Ohio Cooperative Extension Service initiated a Rapid Adjustment (RA) Farm Program to conduct on-the-farm demonstrations showing that superior farm production and management techniques will rapidly increase farm income. Program cooperators selected are younger farm families having a strong desire to farm, but because of under-used or limited resources, have low farm incomes. For five years the farm families receive intensive assistance from Extension in needed disciplines to maximize farm income. Most cooperator farms selected have been in the unglaciated Allegheny plateau portion of Ohio which favors forage and livestock enterprises. To assist and encourage the farm family in making the recommended adjustments, business and industry sponsors provide \$1,000 per year per farm. In most cases the Tennessee Valley Authority (TVA) provides \$500 worth of fertilizer and local business firms interested in agriculture and the community donate the other \$500. Soils on RA farms typically are initially below pH 5.5, low in

\*Author to present paper

Phosphorus (<22.4 kg/ha, Bray P-1) and sometimes also need corrective Potassium applications. After proper liming and fertilization plus use of other recommended agronomic practices, farms have recorded yields more than double county averages for corn, alfalfa and other forages. The RA farms are extensively used for educational purposes. Extension personnel gain satisfaction and confidence from close cooperation with RA families. Data from seven RA farms which have completed the program will be shared. A discussion of successful and problem areas of management will be included. Farms specializing in dairy, or beef and/or swine with grain enterprises have shown most overall progress. Those with major enterprises of fruit (strawberries, grapes, peaches, apples), vegetables, and sheep have been less successful financially.

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## **54 THE ECONOMIC IMPLICATION IN THE APPLICATION OF NEW TECHNIQUES TO HILL SHEEP FARMING IN SCOTLAND**

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**Hill Farming Research Organization, Penicuik, Midlothian, Scotland**

The changes that have taken place in the Scottish hill farming industry relative to labour, net income, and government subsidy support are briefly examined. The implications of these changes on the future development of the industry are discussed.

During the last six years improved systems of hill sheep management have been developed by the Hill Farming Research Organisation (H.F.R.O.), and a method of analysis to examine the economic consequence of these developments on capital investment, cash flow and net income has been established. A computer programme of the method has been written and designed for use on a multi-access system, access being the teletype.

This programme is briefly discussed.

Some of the conclusions reached on the planning of improved systems of hill farming in Scotland as a result of the use of this programme and from the results of H.F.R.O. field development projects is presented.

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## **55 THE ALLEGHENY HIGHLANDS PROJECT: AN EXPERIMENT IN PACKAGED, TEAM-APPROACH TECHNOLOGY FOR HILL LAND LIVESTOCK PRODUCTION**

**L. Balliet**

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In 1970, West Virginia University was awarded a three-year grant by the Rockefeller Foundation to undertake an experimental program of assistance to sheep and beef cattle producers in the Appalachian hill lands of east central West Virginia. The program, known as the Allegheny Highlands Project, is designed to provide livestock producers with a full complement of technical services to demonstrate and more fully utilize the area's vast potential for grassland agriculture. Cooperating farmers receive advice and assistance from a university-trained field staff of specialists in forage and crop production, livestock production and marketing, animal health care, and overall record keeping and farm planning. Five years of program activity (the program was re-funded and expanded in 1975) have resulted in both success and failure. As a whole, project cooperators have expanded their livestock operations through improved forage/crop, livestock produc-

\*Author to present paper

tion, and animal health care practices. Financial returns on investment, although still very low, have likewise shown improvement. The major problems encountered by the project and its staff have involved matters of organization and human relations more than technology. Adoption of new practices has been less rapid than expected, in large part as a result of the project's failure to fully effect an integrated team approach to hill land livestock agricultural development. However, the project has demonstrated that primary contact between producers and agricultural specialists can facilitate the implementation of appropriate technology. The full text of an in-depth evaluation of economic, social, and attitudinal factors associated with the Allegheny Highlands Project is available from the Office of Research and Development, West Virginia University, Morgantown, West Virginia, 26506, U.S.A.

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**56**

### **FORAGE IMPROVEMENT IN APPALACHIAN OHIO THROUGH SOD SEEDING**

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Since 1973, a major emphasis in forage crop Extension education in the southeastern unglaciated Allegheny plateau portion of Ohio has concerned no-tillage forage establishment or sod seeding. This new method offers an effective way to renovate forages on land with 18% or more slope without the danger of soil erosion inherent where plowing or disking is practiced. Farmers and persons advising farmers also recognize the lower power and labor requirement advantages. Introduction of legumes and higher producing tall grasses into poor pastures and meadows, coupled with liming and fertilization often has more than doubled animal carrying capacity. The educational program with sod seeding has centered around supervised farm demonstrations of .4 to 4.0 hectares, established in cooperation with agribusiness. Most seedings to date were made with the Midland Zip Seeder or using modified no-tillage corn planters. In 1974, The Ohio Cooperative Extension Service started 15 FERTIBULL farms, with nine in southern or southeastern Ohio to demonstrate maximized cow-calf production from 24.3 hectare units of pasture. A minimum of 25 spring-calving cows and one bull are being maintained solely from forage production from the unit. Suitable grass and legume species were seeded, mostly by the no-tillage method, in the summer and winter pastures. Summer pastures are rotationally grazed with excess production harvested for later feeding. First growth of winter pastures is field-stored in round bales or stacks for late winter feeding, while regrowth is pastured in late fall and early winter. During April, 1976, 13 sod seedings were established in 12 southeastern Ohio counties using the new John Deere Powr-Till seeder. Farmer interest has greatly increased in no-tillage forage establishment since the first demonstrations. Rental seeding equipment is now available in many counties from dealers or through local agricultural organizations and some farmers have bought their own seeders.

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**56A**

### **INTERDISCIPLINARY RESEARCH-AND-ACTION IN THE UTTAR PRADESH HILLS**

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\*Author to present paper

The hilly region of Uttar Pradesh is located just west of Nepal. It accounts for 17% of the state's land area, and contains 4% of its population. Despite the seemingly low density of population, hill people find great difficulty in earning an adequate living from the rugged terrain. Furthermore, population growth is causing farmers to expand their cultivation to steeper and more marginal lands, with a consequent increase in erosion and probable fall in farm productivity. Soil loss poses a threat to food-producing areas in the plains through increasing the chances of floods and silting up reservoirs and irrigation systems. Plainsward migration of hill peoples adds to the numbers already seeking jobs there. From 1973 to 1976 an interdisciplinary group of scientists at the G.B. Pant University of Agriculture & Technology, Pantnagar, Uttar Pradesh, researched and worked with government on the special problems facing rural development in the Uttar Pradesh hills. Based on that experience, this paper discusses four priority areas for further hill research-and-action.

## 57 CROP PRODUCTION OF ARABLE—AND MEADOW-CULTIVATED PLANTS, IN HIGH AND LOW POSITION

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The report is an account of results based upon a great many series (groups) of experiments in high and low position. The territory is limited in south-north direction between 60 and 62 degrees north latitude. Based on the central valleys, the lower border for our designation hill- or highland descend to 300-350 meter above sea level, and the upper to about 700-750 m. Above that limit, we have the mountain. The area beneath the 300 m border represents the flatland or the lowland.

The period of experiments relate to the years 1945-1970. As an average of the years, the following results are set up, calculated in fu. or kg. per decar. The comparatives are related to the hill-land position (Løken).

		Arable-experiments			
Rotation experiments		Hill-land	440 fu.	Lowland	375 85 %
Potatoes, roots (dry matter)		"	860 kg.	"	704 82 "
Barley (grain + straw)		"	471 fu.	"	420 90 "
		Meadow-experiments, kg. hay			
Møystad.	Lowland.	Lay. 175 m altitude	.....	1000	107 %
Løken.	Hill-land.	" 550 "	"	.....	930 100 "
Berset	Mountain.	" 1000 "	"	.....	720 78 "
Berset	Mountain.	Nat. 1000 "	"	.....	520 56 "

The experiments are accomplished on well cultivated land. The manuring is complete, without any big difference between high- and lowland. I attach the balance between high and low position, which here is demonstrated, mostly upon soil and climate. As a rule the yields in upper situation balance fairly well up that of the lowland.

## 58 CROP DIVERSIFICATION IN LOWLAND BOLIVIAN HILLS

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More than 500 economic crops can be grown in life zones similar to those in which coca (Erythroxylum coca Lam.) is grown in Bolivia. Fewer than 100 of these should even be considered for the classical terraced coca fields in steep Andean terrain. Desirable features in proposed alternative crops for coca include perenniality, light-weight high-priced end product, high hand-labor inputs (the terrain is such that standard mechanization is out of the question), guaranteed market, drought tolerance, and climatic adaptability. Such features might enable a crop to compete with coca as a money crop. Since coca can add significant amounts of calcium and iron to the diet of those who ingest it, food items high in calcium and iron might be desirable for Bolivians who stop ingesting coca.

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## 59 APPRAISING LAND POTENTIALS FOR COMMERCIAL APPLE PRODUCTION

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A study of major commercial apple producing areas shows that they continue to shift, increasing in some areas while declining in others. Historically production has centered on more marginal farm land and sites, often on hilly terrain and near larger centers of population. Severe winter temperatures resulting in tree damage and insufficient cold to satisfy the rest period have been the primary environmental factors limiting distribution of apples throughout the world. Most other environmental and biological factors have been minimized by cultivar (variety) selection, cultural techniques and more effective modern pesticides. More detailed analysis of apple production in the state of Washington has required a re-evaluation of environmental and biological factors previously established to appraise land potentials. Of increasing importance have become temperatures during the growing season: nighttime temperatures, heat units and number of frost free days. Wind and rainfall pattern related to intensity, duration and frequency. Topography, slope and aspect have become increasingly important because of their relationship to spring frost, harvest and mechanization. Distance to the market has become less critical than proximity to skilled labor and housing, technical assistance service and supply centers, large storage and packing facilities and major centers of transportation and sales. The interaction of these factors can be well illustrated and have had a major effect in the decline of some areas and the rate of development of new areas. A new classification scheme is proposed which re-evaluates environmental and biological factors influencing the potentials of land for commercial apple production.

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## 60 TREE FRUIT PRODUCTION IN THE MOUNTAINS OF THE CENTRAL ATLANTIC STATES

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\*Author to present paper

Tree fruits, primarily apples and peaches, are produced in mountain orchards of New York, Pennsylvania, Maryland, West Virginia, and North Carolina. These orchards are characterized by slopes as steep as 60° and thin shale or chert soils. Production rates are low, probably because of the low water and a sufficient holding capacity of the soils. Mechanization has been somewhat slower in the mountain orchards but local labor was abundant until recently. Crop losses caused by spring frost and hail seem to be less in the mountains than in valley orchards. During the first half of the twentieth century mountain grown fruit established a reputation for high quality, which generally meant red color. Cool nights during the later stages of fruit development promotes red color formation and are more likely at higher elevations than in adjacent valleys. The higher prices received compensated for lower tonages and less efficient production. Introduction of strains with greater genetic coloring potential and shifting labor availability threaten the continued economic survival of mountain orchards in the eastern United States.

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**61 DEVELOPMENT OF DISEASE RESISTANT POTATO VARIETIES FOR HILL LAND CULTURE IN WEST VIRGINIA**

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**62 NO-TILL CORN PRODUCTION IN TALL FESCUE**

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Rolling hill-land soils of the Southern Piedmont region are highly erosive when clean tilled. A mild climate and good year-around distribution of 125 cm average annual rainfall permits growth of summer and winter crops when soils are properly limed and fertilized. Close growing forage crops are well adapted to the region. The Southeastern U.S.A., of which the 18 million ha of the Southern Piedmont is a part, is a grain deficit area.

In 1969 a series of field studies were initiated on Cecil sandy loam to develop no-till techniques for growing corn (*Zea mays* L.) for grain in viable tall fescue (*Festuca arundinaceae*, Shreb.). The study objective was to combine no-till corn production in fescue with irrigation to provide summer grain production and winter grazing on fescue. Sub-objectives included establishment of fertility and irrigation requirements, optimum corn populations and row spacing to maintain productive fescue, fescue competition effects on corn grain yields from live, stunted, strip-killed and killed fescue sod, and micrometeorological conditions in the double canopy.

Results indicate that corn grown in 20-cm killed fescue strips, 102-cm rows, irrigated to maintain mean soil water suction in the top 30 cm below 1 bar; fertilized adequately with N, P and K, and soil pH maintained at 5.5 to 6.0 gave optimum grain and fescue yields. Three year average grain yields on this strip-killed treatment were 7734 kg/ha with fescue yields of 4759 kg/ha. When the fescue sod was completely killed, the 1 bar treatment yielded 9,094 kg/ha of grain. Rye yielded 6,257 kg/ha forage yields in spring when planted following corn on the killed fescue sod.

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\*Author to present paper

**63****TILLAGE OPTIONS FOR CROP PRODUCTION ON SLOPING TOPOGRAPHY**

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Soils on sloping topography are an undeveloped resource for grain production. Well and moderately well drained medium textured soils in Ohio on slopes up to 18% have responded to reduced tillage with yields 40 to 50 percent above the state average for corn. New technology in the area of planting equipment and herbicides has provided this opportunity for higher yields. Decreased cost of production and higher yields has resulted in increased profit of 75 to 100 dollars per hectare. Reduced tillage - shifting from conventional plowing to chisel, disc or no-tillage reduces the potential for soil erosion by 1/3 to 1/6 based on field studies and calculations using the universal soil loss equation.

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**64****RELATIVE IMPORTANCE OF THE ALTITUDE DIFFERENCES IN ECONOMIC EFFICIENCY: A CASE STUDY OF THE HAZELNUT PRODUCTION IN THE ORDU AND GIRESUN PROVINCES OF TURKEY**

**K. Somel\* and H. Kasnakoglu**  
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Hazelnut production has an important place in Turkish agriculture with about 4 million persons earning their living in activities related to hazelnut production and as the third largest export crop. This paper attempts to measure the relative economic efficiency of the hazelnut producers in the two provinces of Ordu and Giresun. A distinction is being made between the technological and price efficiencies and the relative importance of the inefficiencies in technology and optimizing factor proportions in the deviation of the realized profits from the maximum profits is analyzed.

The efficiency differentials between the hazelnut producers are than explained with respect to land ownership, region, altitude, ages of hazelnut trees, kinds of hazelnuts produced, etc. It is of importance to see to what extent the technological disadvantages implied by hazelnut productive in higher altitudes are realized, if and to what extent they are compensated with relatively more efficient allocation of the factors of production.

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**65****CROPPING OF LUPINUS SPECIES ON HILL LANDS IN SUB-TROPICAL AREAS ON THE EAST COAST OF AUSTRALIA**

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Climate, and soils of hill lands in sub-tropical areas on the east coast of Australia are described. Pastures are dominated by warm climate species and hence oversowing techniques can be used to sow annual cool climate leguminous species. In 1975 an experimental program was initiated to investigate the usefulness of Lupinus species when used either for forage or for grain production. Results from the first year indicate that dry matter production from Lupinus albus and L. angustifolius was greater than that from L. luteus.

\*Author to present paper

Differences in production resulting from varying plant population densities decreased over time because of extensive branching by plants at the lower populations. L. luteus had the highest in vitro digestibility. Grain yields from L. albus averaged 2.4 t/ha and were significantly higher than those of L. luteus (0.9 t/ha). There was no significant effect of population density on grain yields.

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## 66 IRONBARK RIDGES – PROBLEMS OF UTILIZATION

W. H. Johnston

Wagga Wagga, New South Wales, Australia

Ridges in south-western N.S.W. occupied principally by Mugga Ironbark (Eucalyptus sideroxylon) require careful development and management to remain stable under agricultural production.

The ridges are areas of low relief on highly weathered sedimentary and metamorphic parent material. Yellow solonchic soils are dominant with a minor occurrence of red solodic soils. They are infertile and show large variation in moisture holding capacity and subsoil drainage.

Although land-use is not intensive, development is frequently associated with severe soil erosion due to adverse soil conditions and the difficulty of establishing and maintaining plant cover.

These problems are examined in relation to soil conservation practices and in the light of current experimental findings.

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## 67 A 20-YEAR STUDY OF PASTURE DEVELOPMENT THROUGH PHOSPHATE AND LEGUME OVERSOWING ON NORTH ISLAND HILL COUNTRY OF NEW ZEALAND

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More than 20 years of research has been conducted on steep unploughable hill pastures at Te Awa, in the North Island of New Zealand. Over this period experiments on pasture improvements were carried out. The trials commenced on poor unimproved hill pastures which had an original carrying capacity of about 3 ewes per hectare in a district where rainfall averaged 1062 mm per year. With pasture improvement, carrying capacity increased markedly to the extent that over the last 10 years of the trials a stocking rate of 17.3 ewes per hectare was maintained on the highest stocking paddocks. It was apparent that heavy top dressing with superphosphate gave satisfactory returns only when stocking rates were high enough to insure full utilization of increased pasture growth. Pasture and animal behaviour was studied at four stocking rates. At higher rates yields of animal products were lower per ewe but higher per hectare than

at lower rates. The practical aspects of pasture improvement as applied to hill farming are discussed.

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**68 STABILIZATION OF HILL AREAS UNDER ADVERSE GRAZING AND CLIMATIC CONDITIONS AT WAGGA WAGGA, NEW SOUTH WALES, AUSTRALIA**

**C. M. Adamson**  
Wagga Wagga, New South Wales, Australia

Results from runoff plots located on a fifteen percent slope showed that intensive grazing of natural pastures in a semi-arid environment markedly increased runoff and soil erosion.

The results were compared to two adjacent catchments. One catchment was unimproved, retaining the native grass vegetation. The other was soil conserved and pasture improved. Both catchments were evaluated under heavy grazing pressure.

The treated catchment recorded negligible erosion loss under stocking rates double those used on the untreated catchment. Soil loss from the untreated catchment was up to sixty times greater.

Soil conservation treatment increased depression storage while the improved pasture resulted in higher yields and increased surface detention storage.

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**69 UPLANDS SOILS OF CO. LEITRIM, IRELAND**

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County Leitrim is situated in north-central Ireland. It occupies an area of 613 sq. miles (1,876 sq. km.). The lowland consists mostly of drumlin topography and ranges in elevation from 150 to 400 ft. (45 to 122m) O.D. The upland consists of both gently and steeply sloping hills and mountains with a maximum elevation of 2000 ft. (610m) O.D. This area occupies about 24% of the county. A wide variety of soils - Lithosols, Rendzinas, Brown Earths, Podzols, Peaty Gleys and Climatic Peat - occurs in the upland. They present many problems for management and reclamation. The average annual precipitation ranges from 1250 to 1500 + depending on the elevation.

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**70 THE DEVELOPMENT OF LOWLAND TUSsock GRASSLANDS IN S. E. NEW ZEALAND**

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South Otago Farm Consultancy, Balclutha, New Zealand

New Zealand has about 4½ million hectares of useable developed grassland hill country and 6 million hectares of tussock grasslands of various types and altitudes which over the past 20 years have gone through a revolutionary phase of improvement. This paper discusses the methods of development by practical farmers in a lowland tussock grassland area, covering about 80,000 hectares in S.E. New Zealand where the improvement in pasture carrying capacity has been increased from 0.6 ewe equivalents (EE) per hectare to 8.5 EE per/ha. on unploughable land and to 15 EE. per/ha. on ploughable land. This has been achieved mainly through the application of improved technology and management development in New Zealand through applied research.

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## **71 THE CONTOURING OF HILL LAND INTO LINKED NARROW TERRACES FOR TREE CULTIVATION**

**L. Lisa**

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The paper illustrates a method of hill land arrangement for the growing of trees in rows which allows complete control of rainfall and facilitates the operation of agricultural machines especially when they turn at the end of the row. The contour graded tree rows have a uniform longitudinal gradient; the cross slope may be levelled in terraces with inwards gradient or left with the original slope, in both cases with outlet furrows for water run-off. The terraces are joined at the headlands in groups of two or four by connecting, level or slightly sloping areas which are convenient for turning cultivating machines round into the next terrace. This arrangement of hill land has been experimentally used for vine cultivation and hedge-trained plum-tree growing, and has given, up to now, satisfactorily results.

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## **72 COVER CROPS, MULCHING, GRASS BARRIER AND GRASS WATERWAY ON SLOPELAND ORCHARD**

**Hsiao-tsai Wang**

**Fengshan Tropical Horticultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan, Republic of China**

Bench terracing has been as a major practice of soil conservation in the past years in Taiwan. But its construction and maintenance cost is rather expensive especially when labor-shortage becomes a serious problem in recent years. When fruit trees are planted on bench terraces, farm transportation and operation are quite inconvenient especially when farm machines are used. According to the past experiments (the author made), the water and soil losses on reverse slope bench terrace was higher than that of the treated soil with cover crops or other agronomic practices, and the yield of main crop was lower on bench terrace.

Based upon above information, the author has started in cover crops, mulching and grass barrier on slopeland orchard since 1962. These are inexpensive and

effective measures which may serve the purpose of erosion control. The main achievements are as follows:

(1) Cover crops and mulching:

The cover crop of Bahia Grass (*Paspalum notatum*) has good effect on run-off and soil loss. However, strip cover-crop and mulching with Bahia grass is the best treatment of all. The results have obtained from experiment on banana plantation since 1969, the soil loss from the plot covered with Bahia grass was nearly none and the run-off rate was only 2.29% which was less than those from level bench terrace. From a 48% slope run-off plot with Bahia grass tolerates shade and is adoptable to a wide range of soil pH and soil textures. Experiments on toxin production of root of cover crops indicate that Bahia grass has the least effect than *Indigofera* and *Centrocema*. Bahia grass also improves the soil fertility and the hydraulic conductivity of soil to a certain extent.

(2) Grass barrier:

The author conducted the experiments of grass barrier method on peanut, sweet potato, soybean, banana and litchee field. In 3 to 4 years' time bench terrace were formed gradually. In order to meet the requirement of steep slope (30%-50%) orchard in Taiwan, the grass waterway is designed in the parabolic cross-section with the flow capacity of 0.026-0.067 m<sup>3</sup>/sec. The suitable grass is *Paspalum* spp.

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## 73

### EFFECTS OF BENCH TERRACE AND IMPROVED HILLSIDE DITCH

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The effect of bench terrace varies with its type. Design of the type is important since the different types determine the different cost and effect. The bench terrace is generally classified into three types, namely, outward slope, level and reverse slope. For expanding the effect of bench terrace in practical use, the author furthermore classifies level bench terrace into retention and drainage types.

According to "National Handbook of Soil Conservation Practices" published by U.S. Soil Conservation Service in 1970, the hillside ditch is in a trapezoidal-shape cross section. The author used this section in 1956 on sugarcane land which gave reduced yield. Then the author modified the section into the V-shape flat bottom type. After large scale field observations and hydrology experiments for comparison, the V-shape ditch was established in 1964 for extension. Up to now, nearly 30,000 hectares of slopeland have been extended with this type. It is more increasing the number of plants, soil moisture holding, and stabilization than the trapezoidal-shape. Also the V-shape ditch is wide enough for passage of small or medium size farm machinery and thus constitutes skeleton of road system which is the basic installation of the modern slopeland farm.

The author and colleagues made a series of further studies. It was found that, comparing the run-off rates from observation plots of reverse slope bench terrace and the V-shape hillside ditch, the initial run-off rate of the former was greater than that of the latter and then the difference was reduced gradually later.

The soil conservation measures vary with the different crops and their cultivation and practices. Sugarcane, pineapple, banana and citrus are the main slopeland crops in Taiwan. The measure of the modified hillside ditch with agronomic practices in between is most effective and economical.

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## **74 FARMABILITY EVALUATION OF BROADBASE AND GRASSED BACKSLOPE TERRACE SYSTEMS**

**H. Wittmuss**

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Grassed backslope terrace systems were installed on 4 fields after the conventional broadbase terrace systems were removed. The different conservation systems were evaluated from the standpoint of total field, terraced, grassed waterway, grassed backslope, parallel and nonparallel areas.

The percent parallel area and total farmable area increased when installed broadbase terrace systems were replaced by parallel grassed backslope terrace systems with tile outlet. The broadbase terrace systems had 24.2% nonparallel area and 9.7% grassed area compared to 20% nonparallel area and 3.1% grassed area for the grassed backslope terrace systems.

Computerized terrace designs planned on topographic maps reduced the time required to plan and stake the terrace systems. Topographic maps made using aerial photography and stereographic plotting methods made possible the planning of many terrace layouts on a given field. The terrace layouts with the best field arrangements and least nonparallel areas were selected for submission for terrace design by the computer. The computer was used to design the terrace system and greatly reduce the personnel input time. The terrace design with the best combination of nonparallel area and soil moving requirement was selected for installation.

Parallel grassed backslope terraces with tile outlet offer the opportunity to solve pollution problems caused by high sediment runoff rates and difficult farming problems caused by the high percentage of nonparallel areas associated with terrace systems. The grassed backslope terrace with tile outlets reduced the soil loss as much as 95% compared to up-and-down hill farming and reduced the nonparallel area from 24.2% to 2% of the terraced area. Lateral soil movement was necessary to reduce the nonparallel area to a minimum.

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## **75 TRADITIONAL SLOPE MANAGEMENT: AN ANALYTICAL APPROACH**

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Long considered impediments to development, traditional (nonindustrial; small-scale) farming and resource management systems are being reappraised for their energy-conserving and labor-absorbing qualities. But operating data and analytical frameworks are needed before these systems can be adequately evaluated. This paper suggests one approach based upon labor (energy) requirements for modifying slopes and surface geometry. Most slope control measures can be reduced to the several phases of materials transfer: excavation or acquisition, transport, and deposition. In traditional systems, these tasks generally are accomplished by labor, rather than machinery. Using examples from Middle America and elsewhere, representative labor inputs are developed for several common slope and surface modification forms, such as terraces, trenches, and mounds, in various types of materials. Although most of the techniques are associated with agricultural use of hill lands, the data are equally applicable to a variety of traditional slope engineering projects. For traditional, low energy societies, transferring the quantities of materials necessary for significant slope or surface modification is a formidable task. There are two basic solutions: reduced scale of operation, or combined power units (massed labor). Slope management

lacks the organizing tendencies of water management and most traditional projects are small, scaled to family or village operation. Over long periods of time, impressive results can be achieved with small labor inputs. For rapid, large-scale slope modification, massing labor may offer an attractive alternative to mechanization, especially in densely populated, labor surplus societies.

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## 76 THE SELECTION AND BREEDING OF PLANTS ADAPTED TO LOW FERTILITY AND TOXIC SOILS

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The natural occurrence of plant species on soils extreme in fertility and toxicity shows that plants can adapt to these extremes. In many cases the adaptation is the property of the whole species. But in many other cases the adaptation is the property only of those populations of the species occurring on the extreme soil. These populations are valuable because a) they can themselves be used for establishment purposes, b) they provide variability that can be further selected by the plant breeder.

Investigations in common pasture grasses and clovers in Britain, particularly Lolium perenne, Dactylis glomerata and Trifolium repens show that there is a wide range of populations with adaptation to different levels of soil fertility in these species, and that the populations from low fertility and hill land soils show considerably better survival on low fertility soils than populations from other soils. Where extremes of metal toxicity exist it can be shown that various grass species especially Agrostis tenuis and Festuca rubra have evolved populations which are metal tolerant : these populations will survive in conditions of metal contamination which are completely lethal to populations from normal soils. This material is being developed for use in the revegetation of extreme soils. Since this material has itself been produced by natural selection it would seem possible to select similar material de novo by suitable screening techniques. Investigations show that this can be done, with a minimum of effort. However, there is one major limitation, that of the presence or absence of the appropriate variability in the initial population.

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## 77 RECLAMATION OF SURFACE MINED AREAS IN THE UNITED STATES

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The total land areas disturbed by surface mining in the United States exceeds 4 million acres, about half of which is the result of coal mining. The U.S. has about 32% of the world reserves of bituminous coal and lignite. If all of these reserves now believed recoverable by surface mining were removed, 46 million acres would be disturbed. Spoil materials consist of soil, subsoil, and unweathered rocks. The spoils are very unstable; have low water-holding capacity; are practically devoid of organic matter and plant nutrients; and may contain toxic amounts of some elements. Those in the Eastern U.S. generally are acidic, with the pH ranging as low as 2.5. Those in the West are often high in sodium. Wind and water erosion are major problems on the denuded spoils.

In the early 1960's, the U.S. Department of Agriculture initiated research to revegetate surface-mined lands. Now, several Federal and State agencies support research to reclaim land disturbed through surface mining. As a result of this research, vast acreages of unreclaimed land are now being returned to productive uses, and newly disturbed land is being restored to its original or a higher level of productivity or use.

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## **78 PROBLEMS OF DISTURBED LAND AREAS AND THEIR CONSEQUENCES AFFECTING THE ENVIRONMENT**

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## **79 SOME GENERAL PROBLEMS OF SOIL EROSION OF DISTURBED LANDS IN THE CARIBBEAN**

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Available evidence is presented to show that problems of soil erosion and disturbed lands in the Commonwealth Caribbean are mainly due to improper land use patterns, resulting from almost exclusive cultivation of plantation crops for export on flat, fertile lands and relegation of food crop production by small subsistence farmers to steeply sloped hillsides with erodible soils. These problems have been aggravated by several cycles of shifting "slash and burn" cultivation, with minimal practice of soil conservation, under conditions of high total rainfall and high rainfall intensities. Erosion problems also occur, but to a smaller extent, on soils under plantation crops and more recently injudicious denudation of hillsides for housing projects has also led to serious soil management problems.

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## **80 THE INFLUENCE OF SOIL AND CLIMATE ON THE PRODUCTIVITY OF GRASSLAND IN HILL AREAS**

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Interest in the improvement of Hill Land has been accompanied by an increase in the demand for specific quantitative advice on the management of physical inputs and basic resources for pasture production. At the same time there has developed a need for more definitive selection objectives in the breeding of improved forage varieties for the uplands. The Hill environment is characterised by its large variability and within it farmers have a wide range of production objectives. A traditional basis for giving advice is provided by practical experimentation but the varied nature of the problems and the increasing costs involved impose limitations on this approach. To make the most efficient use of limited experimentation a means of effectively incorporating acquired data in a general predictive model of herbage production is required. This paper examines a number of aspects of hill climate and soil and their consequence for pasture production and indicates how these aspects may be incorporated in a general production model. The problems

associated with the development of such a model and future research priorities are discussed.

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## 81 RESPONSES OF PERENNIAL GRASSES AND LEGUMES TO SLOPE AND MICROCLIMATE

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Field studies were conducted at Morgantown, West Virginia over a four-year period to determine effects of north- and south-facing slopes on yield, plant disease incidence, and water use of common Kentucky bluegrass (Poa pratensis), Kentucky-31 tall fescue (Festuca arundinacea L.), Midland Bermudagrass (Cynodon dactylis L.), birdsfoot trefoil (Lotus corniculatus L.), and Chemung crownvetch (Coronilla varia). Microclimate parameters measured were: Net radiation; evaporation; air temperature; soil temperature of bare soil at the surface and at 2.5 and 7.6 cm soil depth, with and without vegetation; precipitation; soil moisture content; and evapotranspiration rates of each species.

Early spring growth was greater for all species on the southern exposure but total yield was higher on the northern exposure for bluegrass and birdsfoot trefoil. Bluegrass produced from 1½ to 3 times as much forage on the northern exposure as on the southern exposure. Bluegrass, fescue, and birdsfoot trefoil production were limited by high soil temperature, low soil moisture, and more plant diseases on the southern exposure. Tall fescue and crownvetch produced equally well on both exposures, but yield distribution was affected by exposure. Midland bermudagrass produced higher total yields on the southern exposure (approximately 20 metric tons/ha) than on the northern exposure (12 metric tons/ha).

Air and soil temperatures were higher, air movement was greater, net radiation, evaporation, and evapotranspiration rates were higher, and available soil moisture was lower on the southern exposure than on two northern exposures. Soil temperature differed by 23 C or more between northern and southern exposures. Soil temperature was modified considerably by the presence of snow cover.

Sclerotinia crown and stem rot severely affected crownvetch on the northern exposures during early spring but was never found on crownvetch on the southern exposure. Stemphylium leaf and stem spot on birdsfoot trefoil and diseases caused by Helminthosporium dictyloides on bluegrass and H. vagans on tall fescue were more severe on the southern exposure than on the northern exposures.

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## SOIL-PLANT ECOSYSTEMS IN TROPICAL HILL COUNTRY

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Tropical hill lands present a wide array of environmental conditions, resulting in a multiplicity of ecological niches. The growth of crop and pastures is greatly affected by the wide variation in environmental factors. Aerial sowing of a broad mixture of tropical grasses and legumes in steep Hawaii wetlands (annual rainfall 2000-2500 mm) resulted in species stratification and greatly differing sward composition, depending upon position on the hills -- ridgetops, valley bottoms and slopes (north-facing, south-facing, steepness, narrow spurs, etc.). Ecological studies involving measurement of responses of pastures and weed species to

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\*Author to present paper

environmental factors pointed out significant influences of the hill environment on species establishment, growth, and persistence under grazing; values for important environment factors differed greatly over short distances. Near valley bottoms, there was a marked increase in the following soil factors; moisture, depth of topsoil, total N, exchangeable cations (Ca, Mg, Mn), and pH. Species responses varied; stylo (Stylosanthes guyanensis) grew mainly on less fertile ridgetops, intortum (Desmodium intortum) and green panic (Panicum maximum var trichoglume) grew best on lower slopes and in valley bottoms. Stylo distribution was influenced strongly by soil depth and soil pH, while intortum growth patterns corresponded closely with soil moisture, soil N, Ca, and Mn. Green panic distribution was closely related to soil moisture, N, and Mn gradients. Ecological studies can be a valuable tool in understanding and predicting plant growth in the complex hill environment.

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## **83 UNDERSTANDING HILL LAND ECOLOGY IN NEW ZEALAND AS A BASIS FOR MANAGEMENT**

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The evolution of New Zealand hill land pastures has occurred as a result of cultural interference with a wooded landscape. In the moister and milder climatic zones, this change has been deliberately induced by European man. In the colder or drier environments, it was through Polynesian fire that tussock grasslands evolved by migration of species from above timberline or from enclaves in the forest. The climatic and soil factors which affect the ecology of pre-European grasslands likewise affect the cultural requirements for and success of pastoral development. Hill land ecology is presented as an understanding of hill land use systems which include man as manager and which are linked in complex ways with other agrobiosystems and other resource use systems outside them. This understanding is presented as a basis for choosing among the resource management options: 1. of abandoning or combining or continuing exclusive pastoral use, 2. if continuing pastoral use then of managing existing resources or developing them, 3. if developing them then how and for what.

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## **84 ENERGETIC EFFICIENCY OF ANIMAL PRODUCTION IN HILL ENVIRONMENTS**

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## **85 LAND REHABILITATION IN THE UPPER SOLO RIVER AREA**

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The Solo river on the island of Java is notorious for its eroded hills and sudden floods, causing misery and poverty to people living in the area and beyond. Starting in 1973 work has commenced to rehabilitate the land, in close cooperation with the World Food Programme. Several years of intensive efforts in pilot projects

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of the Upper Solo river area, relying mainly on Government funds, have achieved hopeful results. However, contradiction still prevails between continuous cultivation of eroded soils by poor farmers and hope in a better future through land reclamation. Besides, extensive land rehabilitation might be far off, if not impossible, due to lack of funds of the individual farmer, presently living at a subsistence level.

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## **REHABILITATION OF THE LYNX CREEK WATERSHED DEGRADED BY PAST MINING ACTIVITIES**

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Lynx Creek drains a mountainous watershed of the Prescott National Forest. Lynx Lake was created by damming the creek in 1962. Recreation is the major present land use. The watershed was a famous mining district in the beginning of this century. However, there have been no significant mining activities in the area since the mid thirties. Most of the patented claim areas have been used for summer homes. Impact of abandoned copper mine spoils and tailings on the watershed environment is analyzed. Sheldon Mine Complex is a continuous major source of toxic mineral and sediment pollution into the Lynx Lake. High toxic mineral pollution is damaging aquatic life in the lake. Lynx Creek carries high sediment loads during the storm events and is reducing the lake capacity at an alarming rate. The Sheldon Mine Tailings were regraded, limed and dressed with top soil. The disturbed area was hydroseeded with a mixture of native and introduced grasses and legumes. After two months of seeding an effective vegetative cover is established. Results appear promising. Preliminary observations indicate that the most refractory abandoned mine tailings and spoils have high potential for reclamation and thus, reducing toxic mineral and sediment pollution into the Lynx Lake.

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## **REVEGETATION OF STEEP OUTER SLOPES FOR EROSION CONTROL IN STRIP-MINED AREAS**

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Steep outer slopes resulting from strip mining for coal in mountainous terrain create complex problems associated with the reclamation of mined areas. Sheet erosion of the steep outer slopes combined with highly acidic spoil material are the main obstacles to establishing vegetative cover on strip-mined spoils in Appalachia. A practical means of stabilizing the spoil material is the establishment of persistent vegetation. Unless the steep slopes are vegetated immediately after disturbing the soil, serious erosion results, destroying emerging vegetation and leaving permanent, deep gullies. The construction of lateral grooves approximately 18" to 24" apart down the slope, on the contour and parallel to the main bench area will aid the retention of fertilizer and seed during germination and aid early seedling development. Two strip mine sites in West Virginia, White Oak Mt. (pH 3.8 to 4.0) and Bolt Mt. (pH 2.9), were prepared for revegetation using the lateral groove technique. The selection of spoil amendments to neutralize the

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spoil acidity and furnish plant nutrients to ecologically adapted plant species (grasses and legumes) is of primary importance. At both locations the experiments were conducted on a split plot design with 3 rates of phosphate rock compared with superphosphate in the main treatments. Each plot was divided in half and randomly seeded to a legume either directly or by transplanted greenhouse grown seedlings. Birdsfoot trefoil (Empire) was used at White Oak Mt. and both trefoil and crownvetch (Pennsgift) were used at Bolt Mt. All experiments were overseeded with weeping lovegrass to provide quick cover and stabilization. At both sites excellent ground cover was established by both the grass and legumes in the seeding year. Direct seeding was just as effective as the transplanted seedlings in establishing vegetative cover. Birdsfoot trefoil dry matter yield from White Oak Mt. indicate 5680 and 6380 kg/ha from amendments of 9 Mt/ha of phosphate rock and 290 kg/ha  $P_2O_5$  (superphosphate), respectively. On the more acid spoil at Bolt Mt., birdsfoot trefoil yield was 4280 and 3300 kg/ha for phosphate rock and superphosphate, respectively. Likewise, the yield for crownvetch was 4000 and 4200 kg/ha.

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## PLANNING CRITERIA AND USE OF HIGHLY DISTURBED SOILS

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Chemical and physical analyses of overburden materials in the Eastern and Interior Coal Provinces indicate that the Acid-Base status is the primary criterion needed for construction of new minesoils for particular uses. Rock type, status of available nutrients and rock stability are secondary criteria used in pre-planning minesoils. In addition to these overburden properties, future land use is dependent on minesoil properties such as particle size and its relationship to water retention, compaction of soil materials, and the influence of coarse fragments.

A system for classifying highly disturbed soils at the Family level of Taxonomy, which has been proposed as a revision of Soil Taxonomy, was developed to show both short and long range land use. Spolents, constructed by using detailed planning criteria and those constructed utilizing no pre-planning, have been developed. Appropriate Phases of Families are useful for short range management. Implications of these properties will be discussed.

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## RECLAMATION OF MINED HILL LAND—MANAGEMENT FACTOR INTERACTIONS

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Significant research results of mined-land reclamation studies have provided remedies to improve success on toxic materials, prescribed appropriate plant materials and their management, and suggested optimum regimes for many other edaphic, climatic and biologic parameters. To insure reclamation success, these specialized conclusions need to be integrated into the broad universe of multiple interactions among the above and other influential elements. Mined land that is restored to include steep gradients particularly requires consideration of interactive effects of specific research results to attain the best restoration. Surficial material's properties, slope aspect, degree

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and extent, seedbed preparation, plant species, and amendments added to the minesoil interact more acutely than in level regions. Slope aspect in temperate regions affects plant survival from both direct radiation and soil moisture influences. Chemical, physical, and mineralogical properties influence radiation reflection, soil particle disintegration, erosion, nutrient supply, and amendment requirements. Surface configuration affects aspect, erodible area, and adaptability for future land uses. Final grading affects seedbed, erodibility, and need for mulch amendments. Soil texture and rock content affects seedbed, erodibility, and requisite mechanical amendments dependent upon intensity of the slope. Success of the planted species is affected by tolerance to meteorologic factors, native or amended soil chemical and physical status, adequate seeding technique, and accessibility for maintenance or harvest. Non-optimal soils require amendments and/or manipulation to provide a satisfactory and stable seedbed. The reshaped mined landscape must be amenable to economic utilization of the new land resource. This paper will discuss the above and other factorial interactions in detail to show how an integrated consideration of multiple disciplinary knowledge is essential to mined-land reclamation success.

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## 90 RESPONSE OF FOUR GRASS SPECIES TO ROCK PHOSPHATE ON ACID STRIP MINE SOIL

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Weeping lovegrass (*Eragrostis curuvla*), deertongue (*Panicum clandestinium*), Ky 31 fescue (*Festuca arundinacea*), and little bluestem (*Andropogon scoparius*) were grown in strongly acid mine spoil (pH 3.95) from Beckley, West Virginia. The plant species were grown for 63 days in a greenhouse using triplicate pots treated with 0, 100, 200, 400, 600, 1200 or 2400 ppm rock phosphate. The basal fertilization was 75 ppm N from  $\text{NH}_4\text{NO}_3$  and 75 ppm K from KCl. Weeping lovegrass and deertongue were much more tolerant to the untreated mine spoil and more efficient users of rock phosphate than little bluestem and Ky 31 fescue. The first two species reached 50% of their maximum top yield with 100 to 200 ppm rock phosphate; however, little bluestem and Ky 31 fescue required nearly 400 ppm rock phosphate to produce comparable relative top yields. To reach 90% maximum top yield, lovegrass and deertongue required 600 ppm rock phosphate, while little bluestem and fescue required 1200 ppm. Wide species differences in acid mine spoil tolerance were even more striking in root yields. For example, with no rock phosphate added to the spoil, the roots of lovegrass, deertongue, fescue, and little bluestem yielded 76, 48, 22, and 14% of their maxima, respectively. Root yields of weeping lovegrass actually tended to decrease with rock phosphate rates above 200 ppm, while those of the other three species increased with increasing rates of rock phosphate.

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## 91 TAILORING PLANTS FOR GREATER TOLERANCE TO MINERAL TOXICITIES AND DEFICIENCIES ON HILL LAND SOILS

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Many soils of steep lands are seriously eroded, strongly acid, and deficient in available, essential nutrients. In strongly acid soils and mine spoils, toxicities of aluminum, manganese and other mineral elements, or unavailabilities of essential elements, such as nitrogen, calcium, magnesium, phosphorus, and molybdenum may limit or prevent the establishment and growth of the desired crop. In legume-grass mixtures nitrogen may be a limiting factor because of inhibited rhizobial activity. Some hill lands used for pasture are too steep for use of conventional lime and fertilizer spreading equipment, and application by air may be economically prohibitive. Even when surface soils can be limed, the subsurface soils may remain strongly acid, preventing root penetration and reducing drought tolerance and the use of subsoil nutrients. Thus, some problems of mineral stress in soils cannot be economically corrected with present technology. But certain plant species and varieties differ widely in tolerance to high and low levels of mineral elements in soils, and several such differences are genetically controlled. Hence, a promising alternative or supplemental approach to problems of mineral stress is to select plants more specifically for tolerance to those conditions that cannot be economically corrected. Even in "good" soils fertilizer efficient plant genotypes are possible and needed to reduce crop production costs and to conserve fossil energy and limited fertilizer resources. The proposed genetic approach to the problem of mineral stress requires close collaboration of soil and plant scientists.

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## SPECIALTY CROPS, AN ALTERNATE LAND USE ON SURFACE MINE SPOIL

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In conjunction with stabilization and conservation practices in reclamation of surface mine spoil, additional land use through rotations to high value specialty crops offers diversification and a chance to increase food production in Appalachia. Field experiments with *Zea mays* L. 'Golden Cross Bantam', *Phaseolus vulgaris* L. (bush bean) and *Lycopersicon esculentum* L. 'Big Boy', 'Supersonic' and 'Manapal' were conducted on a surface mine bench area at White Oak Mountain, near Beckley, West Virginia. Stabilization cover of *Festuca arundinacea* L. and *Lespedeza cuneata* L. was plowed down prior to seedbed preparation. The corn and horticultural beans were planted using the wheel-track-plant technique. Lime rates were 0, 4.5 and 9.0 metric tons per hectare with fertilizer treatments of 56, 112 and 168 kilograms per hectare N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. For the tomatoes lime was broadcast to bring the pH to 6.5 - 6.8. Tomato fertility levels compared were 84, 168 and 336 kg/ha of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O respectively. Mulches evaluated included straw and sawdust. Mulch significantly influenced the uptake of 12 elements in tomato leaf tissue as compared to 5 for fertilizer effect. In the sweet corn, straw mulch significantly influenced uptake of 5 elements, whereas fertilizer influenced 7. In the bean study, sawdust influenced only N, Fe and Al, with potassium being significant as a primary fertilizer element. Highest tomato fruit yield, 24 metric tons/ha, was from sawdust mulch and 336 kg/ha N level. For sweet corn 30,720 marketable ears per/ha, weighing 6,170 kg were produced with straw mulch and the high lime and fertilizer rates. Highest yield from the horticultural bean study, 4,320 kg/ha of shelled beans, was obtained with sawdust mulch, 4.5 metric tons of lime and the 168 kg/ha fertilizer rate. These studies are being continued.

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## 93 FACTORS INFLUENCING NITROGEN FIXATION BY SEVERAL WOODY SHRUBS AND TREES

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The factor that is most often limiting when attempting to establish plants on disturbed land areas is nitrogen. Continual fertilization programs over large areas are not practical on a cost or on an energy conservation basis. The use of nitrogen-fixing woody plants in revegetation projects on disturbed lands would to a large degree, solve the nitrogen fertilization problem.

The influences of temperature, light intensity, solar radiation and moisture on nitrogen fixation that occurs in root nodules of several species of trees and shrubs were investigated.

Excised nodules of Alnus, Elaeagnus, and Robinia species have been characterized as to the effect of temperature on their ability to reduce acetylene ( $C_2H_2$ ) to ethylene ( $C_2H_4$ ). Acetylene reduction is an effective means of determining  $N_2$  fixation by root nodules. A maximum  $C_2H_2$  reduction rate for nodules occurs at 20C. At near freezing, the  $C_2H_2$  reducing rate is very low. The rate increases rapidly as the temperature increased until the maximum rate is obtained. Reducing activity decreased sharply between 30C and 40C for all species except E. angustifolia.

Studies of A. glutinosa, supplied with ample moisture showed when solar radiation and temperature increased during the day, the rate of  $C_2H_2$  reduced increased. Light intensity, however, appeared to have no effect.

The effect of moisture on  $C_2H_4$  reduction was observed over a 41 day period with nodules of A. glutinosa. The highest rates of  $C_2H_4$  production occurred on dates preceded by a period of rainfall.

As long as environmental conditions are favorable, nitrogen fixing plants can create and supplement a nitrogen deficient soil enough to enable them and possibly other plant species to survive.

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## 94 RECLAMATION TECHNOLOGY TRAINING IN THE UNITED STATES

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As the nation, and the world, turns to coal as a solution to the energy shortage, responsible planning for controlling the environmental impact of surface mining has been taking place. Due to a national heightening of ecological awareness and the increasingly stringent legal requirements for reclamation of mined areas, mining companies and governmental agencies are searching for trained employees.

Up to now, individuals specifically trained in the science and art of Reclamation Technology have been hard to come by. The demand for trained personnel to solve strip mine reclamation problems has been partially satisfied by professionals with degrees in engineering, agriculture, agronomy, geology, and more specifically forestry. The need for specialized reclamation training programs, incorporating a multidisciplinary training, was soon identified. Several educational institutions across the U.S. are developing Reclamation Technology curriculums.

Generally speaking, a person with a Associate degree in Reclamation Technology assists in preplanning, to analyze the geology of the area to be mined and to plan spoil bank placement to facilitate reclamation. Supervision of spoil grading to control surface water drainage and administration of soil fertility tests are

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important job functions. The Reclamation Technologist coordinates refertilization and planting of grass and trees to return mined lands to pasturelands and forests. Land use planning, as for watershed areas or for recreational development, and the training for participating workmen are other tasks of the Reclamation Technologists.

This paper describes in detail all of the Reclamation Technology training programs in the U.S. Curriculums are compared and analyzed. This paper also advocates the establishment of an independent accreditation organization which would have as its missions, the accrediting of Reclamation Technology schools to insure quality training and undue proliferation of curriculums among educational institutions.

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## 95 DWINDLING WILD LIFE IN THE CHANGING ECOSYSTEM OF THE NORTHWEST HIMALAYA WITH SPECIAL REFERENCE TO RARE BIRDS AND MAMMALS

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Himalaya (Sanskrit Him = snow, Alaya = abode) which remains snow laden at its higher reaches practically throughout the year comprises unique ecological and biogeographical divisions for the occurrence of typical faunal and floral communities in highly diversified climatic zones ranging from subtropical at foothills upwards to temperate, subalpine, alpine and arctic, within a short aeronautical distance of less than 80 km. Nature endowed northwest Himalaya with rich faunal and floral compositions. Drug plants such as Dioscorea deltoidea, Ephedra gerardiana, Artemisia maritima and essential oil plants like Valeriana jatamansi and Juniperus macropode are however fast depleting as a result of extensive exploitation. The population pressure on land, deforestation, indiscriminate hunting and poaching, construction of dams and military operations at high altitudes have abominably upset the natural ecosystems. Many of the beautiful birds such as Rhodonessa caryophyllacea, Ophrysia superciliosa, Lophophorus impejanus and Gennaues hamiltoni and mammals namely Bos grunniens mutus, Capra falconeri falconeri, Moschus moschiferus moschiferus, Panthera unica, Caprolagus hispidus are fast vanishing. These and some other rare and valuable species of birds and mammals are threatened with extinction as a result of human activities in hither-to-fore undisturbed or inaccessible niches. The disturbing situation calls for positive and immediate action to save and preserve them with concomitant rectitude of their habitats.

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## 96 ECOLOGY OF BORROW PITS

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Plant and animal communities of abandoned Rhode Island gravel pits were studied for a two year period. Vegetation analysis was conducted through use of point intercept, belt transect and plot photographic techniques on permanently established transect lines. Analysis of wildlife utilization was conducted through observation periods for birds and trapping programs for mammals. Methods were also employed to analyze ground water levels and soil characteristics which may affect the rate and degree of revegetation. Four basic plant community types were identified within gravel pits, in addition to bare ground areas. These included moss-lichen, herba-

\*Author to present paper

ceous, shrub and forest communities. Initial revegetation of gravel pits occurs rapidly following abandonment. An herbaceous community, usually dominated by Andropogon scoparius, is the first vascular plant community to invade gravel pits. Woody vegetation also appears rapidly, especially those species which have seeds dispersed by animals, such as Robinia Pseudo-Acacia and Prunus serotina. Plant successional patterns and rates vary at each study area due to differences in physical site characteristics. Soil texture, depth to the ground water table, amount of human disturbance and slope of the banks are some of the factors which affect succession. The highest species richness of birds occurred in areas of intermediate plant succession where an edge was created between the gravel pit and adjacent forest type. These areas appeared to be most valuable to forest-edge species of birds which require a habitat in which there is an edge created with two or more distinct community types. The ultimate reforestation of gravel pits would bring about the replacement of forest-edge species with typical forest species. Gravel pits in more advanced stages of succession are more valuable to mammals. Cottontail rabbits and opossums were the dominant large mammals occurring in these areas. Small mammals, especially Peromyscus leucopus preferred shrub and forest communities of gravel pits. Although some individuals of this species were recorded in the open area of one site during a home range experiment, it was determined that these were immature animals which were frequenting the open gravel pit as they dispersed from a larger population in the adjacent forest habitat.

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## RECLAMATION AND MANAGEMENT OF SURFACE MINES FOR GAME AND NON-GAME BIRDS

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Surface mines in the hill country of West Virginia drastically change the land use of the area. Today surface mine reclamation in Northern West Virginia converts forested land to grassland. Reclamation in earlier years differed, but regardless all activities affected various species of birds.

Various management regimes will improve surface mines for possible utilization by ruffed grouse, bobwhite quail, mourning doves, wild turkeys and woodcock. Past and present reclamation also affect local songbirds, especially the sparrows. Populations of these game and non-game species existing on surface mines today are determined by; surrounding habitat, age of mined site, size of the site and the vegetation on the site.

Our purpose will be to outline various detailed reclamation procedures which should have a positive affect on the numbers of these birds on the mine.

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## EXTENDING THE SEASONALITY OF GROWTH OF HILL LAND PASTURES

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A fundamental ecological problem of the uplands of Britain is the growth of natural hill pasture species which is highly seasonal with 75% of annual production occurring in 3 summer months. Hill stocking rates, limited by winter carrying

\*Author to present paper

capacity, are thus very low and summer leaf production is undergrazed. The consequent accumulation of mature and senescing herbage reduces the growth rate of young and nutritious herbage in spring and causes an ever-increasing dilution of pasture quality season by season. Consequently, grazing animals are often poorly nourished prior to mating and throughout pregnancy and early lactation. Hence fertility levels and birth weights are low and mortality rates high in hill cattle and sheep. The major factor causing the short growing season is temperature, with little growth occurring from the native species below 6°C. However, there is considerable inherited variability in grass growth at low temperatures. Grasses from southern latitudes exhibit relatively good winter growth in Britain but are not frost hardy. Little investigation has been made of variations in the low temperature growth of grasses and clovers from northerly latitudes. We have collected pasture grasses and clovers from British, Norwegian and Icelandic localities where natural selection may have favoured ecotypes which are not innately winter dormant and yet are winter hardy. Certain ecotypes of *Agrostis tenuis*, *Festuca rubra*, *Lolium perenne* and *Trifolium repens* have exhibited significantly higher leaf growth rates at 5°C with short photoperiods and low light intensities than corresponding commercial varieties. These ecotypes have also performed well in field trials at altitude and could thus provide useful genetic material for improving hill pasture productivity by extending the growing season. Several of the cold adapted plants had relatively high rates of dark respiration (R) and photosynthesis (P) at 2° and 5°C. The P and R rates of some other species from high altitudes or latitudes are known to be adaptable to low temperatures.

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## SOME ECOLOGICAL AND PRODUCTION ASPECTS OF A NORTH AND SOUTH FACING SLOPE PASTURE SYSTEM

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Field studies were conducted at the Reedsville Experimental Farm, West Virginia Agricultural Experiment Station during the 1966 to 1969 growing seasons. The pasture site was located at approximately 39.5° latitude-N and 79.8° longitude-W at an elevation of 600 meters. The average slope of the pasture sites was approximately 30%, with a range of 15-40% within the individual paddocks. Maximum daily temperature at the soil-canopy interface was approximately 1.5-2.0°C lower on the north facing slope. Due to the less favorable environment for white clover on the south facing slope, the swards contained a higher proportion of grass than clover. The reverse was true for the north facing and cooler exposure. Thus, the initiation of spring regrowth was 2-3 weeks earlier on the south facing slope, this no doubt was a combinational function of the predominate species and somewhat warmer slope. The north facing slope generally averaged 6-10 more grazing days per season than the south facing slope. Total liveweight gain/animal was higher on the south facing slope, however average daily/animal for the grazing season was not markedly different. Total herbage production was also similar on both exposures, but the seasonal distribution was more uniform on the north facing slope.

\*Author to present paper

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## SEASONAL YIELD DISTRIBUTION, N. FERTILIZER RESPONSE AND UTILIZATION OF POA PRATENSIS ON NORTH AND SOUTH FACING SLOPES

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Field studies were conducted during the 1966 to 1969 growing seasons to determine the effect of slope orientation on the forage productivity of Kentucky bluegrass (*Poa pratensis* L.) treated with variable rates and time of N application. The growth rate, total yield, seasonal yield distribution and relative efficiency of N fertilizer utilization were greatly influenced by slope orientation. Total dry matter production was more than 2-fold greater on the north-facing slope. Approximately 90% of the total seasonal yield was produced at the first harvest on the south-facing slope. Splitting the N applications did not markedly affect the seasonal distribution of the dry matter production on the south facing slope. On the north facing slope, higher total yields and more uniform seasonal distribution was obtained by splitting the N applications. Dry matter production per unit of N applied was 3 to 3.5 times greater on the north facing slope compared to the south facing slope.

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101

## THE UTILIZATION OF RADIATION ENERGY IN DIFFERENTLY MANAGED ALPINE PASTURES

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On a pasture in the Bavarian Alps some differently managed paddocks were established.

First: a large holding paddock without fertilization,  
 secondly: a rotation pasture without fertilization,  
 thirdly: a rotation pasture with phosphate and potassium fertilization,  
 fourth: a rotation pasture with complete fertilization and as a comparison, a paddock where the cattle was excluded.

The pasture within the paddocks consisted of different plant communities. The above ground biomass was cut regularly. The organic matter was burned and its energy was measured in calories. The energy offer could be calculated by measuring the global radiation for corresponding intervals of time. The efficiency of exploitable net primary production is represented for both different plant communities and different managements.

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## WATERSHED MANAGEMENT RESEARCH ON THE MOUNTAINOUS WILDLAND IN THE NORTH OF THAILAND

K. Chungkao

Kasetsart University, Bangkok, Thailand

Pilot project of watershed management has been studied since 1965 (for 20-year duration of experiment) on the mountainous wildland of hill-evergreen forest at Kog-Ma Watershed Research Station in Chiangmai, the north of Thailand. The area is enclosed by approximately 160 acres on mean slope of 39% between 1300 and 1600 meters from mean sea level. The main objective of this research is to find out the basic information in forest ecology and forest hydrology in order to apply for management of head watershed of Thailand.

\*Author to present paper

Results found that Kog-Ma Watershed was classified as hill-evergreen forest with annual rainfall 2000-2400 mm, 100-160 rain-days of 10-11 months; mean daily air temperature 69° F (maximum 96° F and minimum 44° F); relative humidity 59-80% in the summer, 80-90% in the winter, and over 90% in the wet season; wind speed 9-19 km per hour; average daily evaporation from U.S. Class A pan approximately 6 mm in dry period, 2.5 mm in the wet season; daily solar radiation for sunny days approximately 600 langleys, and less than 100 langleys for cloudy days.

The soil properties were characterized as granitic coarse texture, pH 5.0-6.0, soil depth 40-200 cm, and moderate to high fertility (natural forest) and decreased seriously fertility after clearing 1-3 years. Sediment yields of shifting cultivation plots showed lower than the natural forest because of more imperata grass roots, and the surface runoff showed in opposite values. An optimum plant cover was found approximately 70 percent for the most use in soil and water conservation of hill-evergreen forest. The chemical analysis of water from rainfall, stemflow, throughfall, and streamflow found that elements output from watershed ecosystem was very low. Streamflow has been calculated approximately 46 percent of annual rainstorm. The studies indicated the amount of throughfall approximately 91%, Stemflow 0.5% and interception 8%.

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#### CARBOHYDRATE CONTENT AND QUALITY IN PLANTS DEPENDING ON CLIMATE CONDITION IN THE NORTHERN ALPINE AREA

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The relatively high productivity of permanent pastures in the hill land area of southern Bavaria rises the question whether there is a profound advantage of hill land as far as radiation and day and night temperature are concerned. Preliminary results confirm the idea that in high land areas moderate day temperature and high radiation accompanied by low night temperature produce plant material of high carbohydrate quality. The report presented will include new data of an expanded trial performed this summer. In the northern alpine area at 450m, 700m, 1000m and 1500m above sea level grasses, legumes and herbs are harvested at two different stages of development in natural grass land. In parallel pot plants were positioned right in the neighbourhood of climate stations of the Deutsche Wetterdienst. Freeze dried plant material was analyzed for free and polymeric sugars and the results are correlated with day and night temperature and the radiation as well, measured at the corresponding places.

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103A

#### USE OF AERIAL TECHNIQUES FOR PASTURE IMPROVEMENT IN THE HILL LANDS OF IRAN

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N.S.W. Department of Agriculture, Orange. N.S.W. 2800, Australia and Ministry of Agriculture and Natural Resources, Saltanabad, Tehran, Iran.

The aim of this project was to investigate the establishment of aerially sown pastures on the badly eroded hill lands in Iran. Half the seed and all the fertilizer were distributed by helicopter on four sites in November 1975 and the remaining seed in March 1976. The species sown were: Agropyron desertorum, A. cristatum, Bromus inermis, B. tomentellus, Dactylis glomerata, Medicago sativa,

\*Author to present paper

Onobrychis viciifolia and Poterium sanguisorba. A mixture of triple superphosphate and sulphate of ammonia was applied.

Results in June 1976 showed that all species established well from each sowing. Young plants had from 2 to 6 and up to 20 leaves. The success of the project will depend on the persistence of these plants.

Establishment was best on bare stone screes, bare waterways, bare animal terraces and areas with deep, fertile soil. Competition from resident plants reduced establishment. Northerly and southerly aspects had no effect on establishment.

Fertilizers appeared to improve growth of young plants and growth of some resident species.

The results indicate that, with further investigations, aerial seeding may have a most important place in reclaiming the hill lands of Iran.

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**103B**

### FERTILIZATION AS A SYSTEM OF MELIORATION OF ERODED PASTURES

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In this communication our only aim is to present some results of the influence of fertilization on melioration of eroded pastures. Field experiments have been carried out on three experimental fields located under different bioclimatic conditions. The soils of the experimental fields are developed on serpentine and they are called humus-silicate soil /Ranker/ and on the limestone and belongs to the rendzinas. Both soils are very shallow, without genetic horizons and they are characterized by the black color /2.5 YR 2/0/. These soils have favourable water properties. Rendzina is weakly alkaline and humus-silicate is a weakly acid one. Both soils are rich in organic matter but poor in available potassium and soluble phosphorous. Among exchangeable cations prevails magnesium in humus-silicate soil and calcium in rendzina. On the experimental fields, as well as on the pastures where is free grazing, there are growing many plants species and from them many which have no value at all from the point of view of cattle's fodder. Two years average yields of the plant mass point both the importance of applying various quantities of mineral fertilizers and importance of the time of their introduction. It is obvious from the yield analysis that single introductions of fertilizers before the vegetation started and in the beginning of vegetation have given the yields which were almost twice as large as those obtained by the introduction in the course of vegetation. Various mineral fertilizers manifested different effects on the yield of the plant mass. Nitrogen fertilizers showed the greatest efficiency, the phosphorous component a somewhat less one and the potassium component is lagging behind. By the introducing of mineral fertilizers is improved the floristic composition of eroded pastures and qualitative and nutritive value of plant mass.

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**104**

### INTENSIVE REARING SYSTEMS FOR SHEEP PRODUCTION

L. Ainsworth

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The development and application of a new method for controlling the estrous cycle of sheep which utilizes intravaginal polyurethane sponge pessaries impregnated with a progestagen has opened up new possibilities for increasing the reproductive output and efficiency of sheep production. This presentation

<sup>\*</sup> Author to present paper

will review the recent advances which have been made in the development and commercial application of controlled breeding and rearing programs for sheep production in Eire, Scotland and France. These programs, which have provided viable models for translating the knowledge and techniques presently available into practical economic realities, have shown a steady increase in performance from the time they were initiated. Attention will also be devoted to the multidisciplinary approach to intensive sheep production currently being carried out at the Animal Research Institute in Ottawa. This latter approach, which will demonstrate the value of taking existing knowledge and techniques derived from various disciplines and putting them together to provide an intensive production system adaptable to Canadian conditions, could have potential application in increasing the efficiency and output of animal production systems under a wide variety of commercial farming conditions.

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## **105 GRAZING SYSTEMS FOR HILL LANDS**

**T. B. Trew**

**United States Department of Agriculture, Soil Conservation Service, Richmond, Virginia, USA**

The hill lands referred to in this paper are the 207 million acres of Appalachia in 19 states from Maine to Alabama in Eastern U.S.A. Topography is steep slopes and sloping foothills with elevations of 500 to 6700 feet. Acid soils were formed under hardwood in four forest ecological regions. The 36 million acres of pasture are grazed by 10 million animal units. Major problems are brush control, overgrazing, and steep topography. Most farmers follow a medium or low level of management and have more than one kind of pasture. Examples of grazing systems are: 1) Two or more cool season grasses; 2) cool and warm season grasses; 3) cool and warm season grasses plus annual crops; 4) cool season grasses and crop residues; 5) other plants. Grazing systems designed to fit the farm, its soils, plants, the livestock enterprise, and the desires of the operator have been very successful, give optimum animal production at low cost, and conserve the soil, water, and plant resources. Deferred or rotation grazing is built into these systems and helps meet plant management requirements. Grazing or harvest is at or near the optimum time. All of these result in healthier more productive plants that are less affected by drought. This adds stability to the livestock industry that depend on these grasses as a primary resource base.

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## **106 PRODUCTION OF PENNSYLVANIA HILL LAND PASTURES FOR BEEF PRODUCTION**

**J. B. Washko and L. L. Wilson**

**Pennsylvania State University, University Park, Pennsylvania, USA**

Pennsylvania has approximately 700,000 hectares of pasture land that is too hilly, rough, rocky, shallow or brushy to be used for any other purpose. Experiments have demonstrated that much of this land can be reclaimed for grazing by the use of the pasture renovation technique or sod-seeding.

Such pastures seeded to grasses alone with nitrogen fertilization produced 363 kilograms of beef per hectare in a 184-day grazing season. Seeded to legume-grass mixtures such pastures produced 378 kilograms of beef per acre. Where steers on these pastures were supplemented with 2.3 kilos of grain per day while on past-

ure those on nitrogen-fertilized grass gained 393 kilos per season and those on legume-grass gained 465 kilos per season at a stocking rate of 0.4 hectare per animal.

Likewise when similar pastures were grazed with Angus-Holstein cross-bred cows and calves they furnished from 225 to 320 days of grazing per hectare per animal unit. Stocking rate for the cross-bred cow and calf herd was 0.6 hectare from May 1 to July 15 and 0.7 hectare thereafter. Calves were weaned at 295.5 to 309.1 kilos in 300 + 7-days.

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## 107 SHEEP AND CATTLE PASTORAL GRAZING SYSTEMS ON NEW ZEALAND HILL COUNTRY

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Over the past two decades much of the grazeable hill country in New Zealand has gone through a revolutionary phase of pasture improvement and increased production. New techniques in the grazing management of sheep and cattle have made a major contribution to the efficiency of this increase. This paper discusses the most successful of these methods and their implications, including systems of rotational grazing, block grazing, set stocking, and on and off grazing etc..

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## 108 COMPARISON OF HAY PACKAGE TYPES FOR BEEF COW WINTERING PROGRAMS

L. L. Wilson\*, W. L. Kjelgaard, P. M. Anderson, J. B. Washko, H. Nehrir and D. Hughes

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Several trials have been conducted comparing chemical composition, brood cow performance, dry matter and feeding value loss, and carrying capacity per acre, with large hay packages and rectangular bales as treatments. In a 117-day wintering trial, with 10 cows in each of six treatments (non-treated corn stalk one-ton stacks; rectangular hay bales stored inside; cold-flow ammonia-treated corn stalk stacks; one-ton hay stacks; string-tied large round bales; non-tied large round bales). Means for the six respective treatments for percent dry matter, subjective quality score (higher number more desirable), dry matter offered per head per day, final condition score (higher number represents greater fatness) were: 76%, 5.7, 30.7 lbs., 9.9; 84%, 6.8, 19.0 lbs., 12.6, 80%, 6.8, 29.2 lbs., 9.8; 78%, 5.8, 26.0 lbs., 10.8; 75%, 4.2, 23.1 lbs., 11.4; and 71%, 4.5, 20.9 lbs., and 10.4. Mean weight changes for cows calving during experiment, and for cows not calving before the end of the trial, were respectively: -168.4, +10.4; +21.4, +129.0; -185.9, +9.9; -73.4, +69.4; -75.0, +47.8; and -145.5, +8.2 lbs. Six non-string-tied large round bales were made from field-cured alfalfa hay at 18% moisture, averaged 14.8% moisture after 7 months of inside storage, and 27.6% moisture after outside storage. Dry matter loss of inside-stored large round bales averaged 3.7%, and dry matter loss of bales stored outside averaged 19%. Generally, a decrease of approximately 2 percentage units in estimated digestible protein was obtained comparing inside- versus outside-stored large round bales, although few significant changes were noted in acid detergent fiber, and *in vitro* digestible dry matter. Preliminary data with application of chemical additives to different types of hay packages indicates minor differences in animal acceptability, but reduced incidences of excessive heating in treated packages. Total dry matter loss from harvest through feeding averaged 18%

\*Author to present paper

for treated hay and 29% for field-cured controls in outside-stored large hay packages.

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## 109 SYNCHRONIZED ESTRUS AND USE OF ARTIFICIAL INSEMINATION IN SMALL HERDS OF BEEF CATTLE

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High labor cost has limited artificial insemination in beef cattle on pasture. Management systems have been evaluated in over 900 animals using prostaglandin  $F_{2\alpha}$  ( $PGF_{2\alpha}$ ) to synchronize estrus and ovulation. In reproductively active heifers and lactating cows, two intramuscular injections of 25 mg  $PGF_{2\alpha}$  12 days apart, followed 40-48 hr. later by 400  $\mu$ g estradiol benzoate, synchronized estrus into a 30 hr. period in 89 percent of the animals. When a corpus luteum was present as determined by palpation per rectum, a single injection of  $PGF_{2\alpha}$  followed by estradiol benzoate was equally effective (92% synchronized). Conception rates varied with technician, herd and service sire. Overall pregnancy rates to first service of 38 to 44 percent of all animals treated were achieved. With further breeding at second estrus during days 20-27 after  $PGF_{2\alpha}$ , a final total pregnancy rate of approximately 85% can be expected. Thus, observation for estrus during days 2-3 and 20-27 after  $PGF_{2\alpha}$  or a total of 10 days resulted in an 85% calf crop born. The expected value of artificial insemination in increasing calf weights will be weighed against the costs of the procedures and labor required to achieve these results for herds of 10, 20 and 30 cows using performance-tested bulls of average price or in the top 10% of bulls sold in the West Virginia Performance Testing Program.

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## 110 INCIDENCE AND METHODS OF PREVENTING GRASS TETANY

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Forty-eight to fifty-six mature beef cows were used each year over a period of three years to determine the incidence and evaluate methods of preventing grass tetany under a conventional winter management system in Southern Indiana. The following methods were tested: no supplemental magnesium, 2.2 kg corn with 56 g MgO, protein blocks (2.5% Mg), hay, free-choice mineral with MgO, free-choice mineral with MgO and corn as appetizer, and liquid supplement (.3% Mg). Each year blood samples were taken from individual cows in December, the last week in January and the last week in February, and at two-week intervals during March and April. Magnesium, Ca, P and K levels in the serum were determined. The results showed that the serum magnesium values decreased from a high of approximately 2 mg % in November and December to a low of 1 mg % during the first part of April when no supplemental magnesium was supplied. The incidence of tetany by year in groups receiving no supplemental Mg was 14%, 1974; 6%, 1975; and 15%, 1976. All but one of the tetany cases occurred each year during the latter part of February and first part of March. The daily supplemental feeding of 2.2 kg of corn mixed with 56 g of MgO was the most effective method in maintaining normal magnesium levels. The least effective method in maintaining normal blood Mg levels and preventing tetany was supplemental feeding of corn, hay or protein

\*Author to present paper

blocks (2.5% Mg). Supplying Mg in a free-choice mineral mixture with or without corn and liquid supplement dispensed in lick tank was intermediate in maintaining blood magnesium levels.

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## **111 GRASS TETANY AS A METABOLIC PROBLEM IN THE EASTERN UNITED STATES**

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Grass tetany, in both spring and winter forms, is a significant problem in beef herds in the NE and the eastern coastal states. Soil and environmental factors affecting the uptake of magnesium by forage plants and the incidence of hypomagnesemic tetany are reviewed, with emphasis on recent studies in Pennsylvania and West Virginia. Trials at the U.S. Regional Pasture Research Laboratory have indicated the feasibility of increasing the magnesium concentration of grasses and legumes both genetically and by fertilization. The effects of forage species, stage of maturity and fertilization on the availability and utilization of magnesium by ruminant animals have been examined in balance trials and feeding studies in West Virginia and a summary of results is presented. Finally, the development of practical and inexpensive supplementation procedures to improve the magnesium status of beef herds is discussed in relation to winter feeding management on hill farms in the Appalachian region.

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## **112 DYNAMISM AND CONFLICTS IN THE MULTIPLE USE OF HILL LANDS**

**W.E.S. Mutch**

**Department of Forestry and Natural Resources, Edinburgh, Scotland.**

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## **113 INTEGRATION OF HORTICULTURAL CROPS WITH CATTLE AND TOBACCO ENTERPRISES IN THE APPALACHIAN AREA OF WESTERN NORTH CAROLINA**

**D. D. Robinson**

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During the past quarter century cooperative efforts of the North Carolina Agricultural Extension Service, the research component of the university, with resources of the Tennessee Valley Authority, have resulted in drastic changes in the enterprise structure of Western North Carolina. The number of farms in 1969 was less than half of that classified by census in 1950; however, the agricultural income has tripled. Farm size has increased, but the acreage of cropland still is below 10 acres per farm. The presentation results from a program that has been designed to assist small farmers in Western North Carolina in solving problems relating to agricultural production. Programs have been modified and updated over this period with the objectives of introducing new enterprises that net over \$1,000 per acre per year and the subsequent introduction of new technology, upgrading of management and improving efficiency to provide a more comfortable level of living on the farm. The nature of limited resources, variation of elevation (1200 to 6600 ft.), length of growing seasons, variations in soil types and ranges in annual precipitation (from 39 to 72 inches) has necessitated consideration of a broad range of horti-

**\*Author to present paper**

cultural enterprises: trellised tomatoes, cucumbers, native ornamentals (rhododendrons, mountain laurel, flame azaleas, etc.). Fraser fir for Christmas trees, apples and greenhouse production are newer ones that have been introduced in recent years. Fragmentation of land over time due to inheritance division has severely limited many farmers in producing a level of livestock output sufficient to provide adequate income. Program variations have had to be designed for different audiences depending on their needs. There is on one hand extensive planning carried out with those having higher resource levels and on the other extreme, those with low levels of resources require one-to-one personal assistance. The development of these enterprises, their effect on labor use, markets, suppliers of farm chemicals, hardware, machinery, etc. the generation of income to farmers and added income to the economy is discussed in a slide presentation which is designed to show the steps involved in getting new enterprises integrated into cattle country formerly associated with the mountainous area of North Carolina.

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## 114 MULTIPLE USE OF HILL LAND IN TAIWAN

C. P. Shih

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Taiwan is an island with a population of over 16 million and an area around 36,000 square kilometers, of which over 70% is hilly and mountainous lands. With the rapid economic development and population increase, considerable part of agricultural land in the plain area has been reduced for urban development, industrial and residential purposes. The average size of a farm has become smaller while the number of persons being supported per farm has increased. As the demand for food grows with the population increasing, it is necessary to develop slopeland for more crop and livestock production. Because of heavy rainfall, steep slopes, erodible soils and intensive land-use patterns, soil erosion is very serious when slopeland is developed for farming. Therefore, soil conservation practices are urgently needed in the slopeland development program. Of the total slopeland area of 2,500,000 hectares, the lands above 1,000 meters elevation are very steep and covered with national forest. In the agricultural marginal land, area between 100 to 1,000 meters elevation, various types of farming produce a wide variety of agricultural products. Due to different elevations, climates, soil conditions and farm size, various kinds of farming types in land-use programs are carried out on regional basis.

1. Establishment of Specialized Production Area: Tea and citrus specialized production area have been established in the North, Sub-tropical fruit such as banana, pineapple, litchee and mango specialized production area in the South. Sericulture development program has been established in East coast and temperate fruit (apple, peach, pear) in high elevation mountain area in the central mountain range.
  2. Integrated soil conservation and land-use program has been established on regional basis since 1966. It helps farmers to obtain better land-use condition by employing proper soil conservation technique and integrate fruit tree planting with livestock raising, as well as improving community facilities such as farm road, irrigation and drainage systems, etc.
  3. Different types of livestock production (Dairy farm, Dairy-beef Farm, Sideline beef farm, Swine farm) in different regions are established according to the transportation facilities condition and labor resources.
  4. New approach of slopeland development work has been undertaken to build up better farm communities in slopeland area in various parts of Taiwan, not only for agricultural purpose but also for community development.
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## 115 LIVESTOCK PRODUCTION AND FORESTRY ON WESTERN HILL COUNTRY

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Hill lands in Western Oregon and Northwestern California offer possibilities of growing softwood timber or grass legume forage for livestock. This is a winter annual area with winter rainfall, dry summers and moderate winter temperatures. Many slopes are relatively shallow and are not suitable to grow trees economically. These areas are satisfactory to grow forage for livestock and forage is probably the most economical use in agriculture. Forage improvement with the use of subterranean clover and grass offers great possibilities when accompanied by a proper fertilizer program and adequate grazing use. Production is increased from 1200 kg. per hectare of native grass to 5000 kg. per hectare of subterranean clover and associated grass. Live weight animal production by some ranchers is exceeding 200 kg. of liveweight animal production per hectare. With most of the year's total forage production coming in four spring months, animal management systems become very important to properly utilize forage produced efficiently. On some sites alfalfa or other clovers may be better adapted for optimum production.

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## 116 SOME ASPECTS OF SHEEP AND BEEF CATTLE PRODUCTION ON NEW ZEALAND HILL COUNTRY

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In New Zealand hill country maximum production seems unlikely to be achieved until a combination of high stocking rates with genetically superior sheep and beef cattle are grazed on improved pastures adequately topdressed with essential nutrients, and planned intensive rotational grazing is practised. A grazing management system is outlined as a workable framework for the application of existing knowledge. Further increases in livestock production are possible through the application of animal breeding knowledge. Faster genetic progress in sheep and beef cattle industries depends, in part, on the wider adoption of national improvement services based on economically important heritable productive traits in sire breeding units. Large-scale co-operative breeding schemes in which high performing animals are transferred to nucleus breeding units are stimulating interest in applied breeding in both sheep flocks and beef herds. Research with Friesian crossbred beef cows also indicates increases in the order of 30% in weight of calf weaned per 100 cows mated (productivity) and 20% more productivity per 100 kg cow weight are feasible compared with existing beef or exotic crossbred cattle.

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## 117 FORAGE-ANIMAL PRODUCTION SYSTEMS ON HILL LAND IN THE EASTERN UNITED STATES

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Hilly lands and soils not suitable for intensive crops are adapted for economic perennial forage-ruminant management systems. Economic potentials for cattle enterprises are in the order listed: 1) raising calves, 2) stocker and replacements and 3) fattening. Fattening operations require limited energy supplements; managed forage systems provide adequate nutrition for the other cattle projects. Efficient calf raising depends on production goals and wise

\*Author to present paper

compromises between production per head and per hectare. This is attainable by controls in species, stages of growth, grazing pressure, and cycling animal production to attain the needed nutrition from forage systems. Cows tolerate variable nutrition -- medium from calving until calves are three or four months old, thereafter low nutrition with high grazing pressure. Excellent calf nutrition is furnished by selective grazing with creep grazing. All-year grazing with little harvesting and hand feeding is done with simple three-field systems. Harvesting and hand feeding increase production per hectare and costs. Systems with stocker and fattening cattle depend on desirable grazing pressures with palatable mixtures high in legumes and adjusting stocking rates with seasonal growth. Allowing first grazers to consume about half of the pasturage augments energy intake and liveweight gains; residues may be consumed by cows with calves creep grazing with first grazers. Limited grain feeding increases liveweight gains and carcass quality.

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## **118 ANIMAL PRODUCTION SYSTEMS FROM HILL COUNTRY IN THE UNITED KINGDOM**

**J. Eadie**

**Hill Farming Research Organization, Penicuik, Midlothian, Scotland**

A brief description is given of hill sheep farming systems in the United Kingdom. This is followed by an analysis of the problem of low output of sheep products from hill land. This analysis includes consideration of the questions of stocking rate and individual sheep performance and its components.

An approach to improving output, based on research on the biology of hill sheep production in the Hill Farming Research Organization, and which takes account of various important non-biological constraints, is described.

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## **119 "TECHNICALLY FEASIBLE, ECONOMICALLY MARGINAL AND A SOCIAL EXERCISE": BEEF PRODUCTION FROM HILL LAND IN FIJI**

**I. V. Partridge**

**Department of Agriculture Research Station, Sigatoka, Fiji Islands**

Much of the undeveloped interior of Viti Levu, Fiji, is steep hill land suitable for beef production. Adequate temperatures and rainfall throughout the year permit good herbage production, especially with pasture improvement by oversowing legumes and fertiliser into the existing grassland. The hill land belongs to the communal native Fijian land owning units - 'Matagali'. Overseas aid has been sought for two development schemes totalling 150,000 ha, with differing systems of production, i) Matagali lease their land for integrated development and large scale ranching by expertly managed legal corporation of landowners ii) individual Fijians take leases to develop separate farms of 250 ha on their communal land, under expert supervision. The financial rate of return will depend on managerial skills and inputs, especially the cost of fertiliser. The economical rate of return is marginal due to the high cost of essential infrastructure especially roading. Several other attempts at hill land development in the S. Pacific region have been unsuccessful.

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## ROLE OF THE SOIL CONSERVATION SERVICE PLANT MATERIALS WORK IN DEVELOPING PLANTS FOR HILL LANDS

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By combining several disciplines, the Soil Conservation Service assists land users develop sound conservation programs. Plant materials responsibility is to assemble, comparatively evaluate, select, cooperatively release and distribute for commercial production plants needed for specific conservation uses. Through this effort more than 200 conservation plants for a wide variety of uses have been developed and released during the past 40 years. We are currently seeking plants for major hill land uses: stabilizing and beautifying surface mined lands and highway slopes; forage plants that extend the grazing season, give better soil protection, and produce superior quality and yield; fire retardant plants to replace brush on mountain slopes; protection of streambank and lake waterlines from erosion; and improved wildlife food and cover plants. Much of this work is done by plant materials centers following a systematic procedure. Several steps make up the procedure. First is to identify the conservation problem. The plants that may have value for solving the problem are collected world wide. These are screened in comparison with known standards. Those showing real promise are selected and increased for advanced evaluation. Advanced evaluations are made on sites that closely resemble the problem being studied. Plants which warrant evaluation beyond advanced testing are produced at the plant materials center to permit final testing on problem sites. These are of adequate size to represent a field-sized or management unit. Superior plant materials are released for commercial production and widespread use. Plant materials centers maintain genetically pure planting stock of the improved cultivar. Many plants have been developed for use in hill land of the U.S. Examples are Chemung crownvetch, Lathco flatpea, Cardinal autumn olive, Tioga deertongue, Critana thickspike wheatgrass, Rosana western wheatgrass, and Durar hard fescue. New cultivars have been released for increasing forage production from grazing land in the western U.S. Siberian wheatgrass, Blando brome, Topar and Luna pubescent wheatgrass, Lana vetch, and Greenar intermediate wheatgrass are used extensively. Current priorities in the east are to improve forage production from hill land with soil and site limitations. Promising species which display potential are tall growing native and introduced warm season grasses.

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## CLIPPING EFFECT ON STAND, YIELD, AND QUALITY OF THREE WARM SEASON GRASSES

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At the Quicksand Plant Materials Center 'Kaw' big bluestem (*Adropogon gerardi* Vitman.), 'Cheyenne' indiagrass (*Sorghastrum nutans* [L.] Nash), and 'Blackwell' switchgrass (*Panicum virgatum* L.) were clipped from one clipping per season to one clipping each month, June - October 1972 - 1974, at three different clipping heights. Seedling stand counts were made, and thereafter visual stand ratings were continued when growth had stopped in the fall and after growth had begun in the spring each year. After 3 years, the stands of all species were reduced. Time of clipping had a significant effect on stand of all species and cutting height affected the switchgrass stands. Yield data showed a significant effect from cutting heights for all species and

\*Author to present paper

time of clipping affected switchgrass and indiagrass. Proteins and DMD were not affected by cutting heights in any species. Time of clipping did affect proteins and DMD in all species.

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## 122 THE IMPORTANCE OF A HILL COUNTRY RIVER (A CASE STUDY OF THE WANGANUI RIVER, NEW ZEALAND)

B.G.R. Saunders

Mass. University, Palmerston North, New Zealand

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## 123 TROPICAL FOREST LAND-USE EVOLUTION IN NORTHERN THAILAND

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Tropical forest land use evolution was investigated over 290 square kilometers in the Nikom Doi Chiang-Dao hill tribe settlement area. The purposes of the study were: 1) to compile a sequential forest/agriculture land use map to determine gross forest/agriculture land use changes, and to utilize it in predicting future land use developments in the study area, 2) to determine the validity of remote sensing for making and updating forest/agriculture land use maps, 3) to integrate historical land use data in mathematical, geographical models of the study area with current satellite land use maps and available maps of regulating physical/biological features to predict future spatial and temporal forest land use patterns. Photo-interpretation was performed on numerous panchromatic black and white photos of various historical dates, 1954, 1966, 1968, and 1972. Sequential forest/agriculture land use maps were compiled, and gross forest land use changes were determined from these maps. One approach for determination of validity of remote sensing data was evaluated on four channel ERTS multispectral scanner imagery in form of black and white prints and false color composites. These evaluations indicated that satellite imagery is a valuable addition to the more conventional forms of aerial photography for detecting and monitoring forest land use evolution affected by shifting cultivation in the study area. The application of this study was extended using satellite imagery to integrated forest/agricultural land use classification of Chiang-Mai province, and for the future forest/agriculture land use classification of the northern region or the entire kingdom of Thailand.

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## 124 HONEY PRODUCTION ON RECLAIMED STRIP MINE SPOIL

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Forty (40) active colonies of honey bees (*Apis mellifera* L.) have been placed on two (2) strip mined sites in the western Kentucky coal field for the purpose of determining the number of pounds of honey that can be produced on spoil material revegetated by tall fescue, alfalfa, white Dutch clover, yellow sweet clover, birdsfoot trefoil, hairy vetch, red clover, and sericea lespedeza.

While gathering nectar from annual and perennial plants used in reclamation efforts, honey bees perform the natural process of pollination. Thus, one of the

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\*Author to present paper

benefits of having honey bee colonies on these newly reclaimed lands is the increased seed production which would result in a more rapid establishment of adequate stands of ground cover. This in turn would effect the rate at which an operator is able to achieve the percentage of vegetative cover on his spoil as required by law. Therefore, by placing honey bee colonies on revegetated spoil the release of the reclamation bond posted by the coal companies may be achieved more rapidly. A purpose of this paper is to identify positive affects on the strip mines involved in terms of increased seed production.

Exactly 195,540,000 pounds of honey were produced in the United States in 1975 and sold at an average price of 50.6 cents per pound. However, an additional 40,000,000 pounds of honey were imported illustrating the existence of a market for increased honey production. This needed increase in honey production can very possible come from utilizing the untapped nectar sources on strip mine spoil. This paper points out dramatic increase in honey production from the nectar sources grown on reclaimed strip mine spoil and illustrates the potential of a new economic resource for individuals and a new end-land use for strip mined land.

Specific hive management techniques that are unique on strip mine spoil are also discussed.

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#### **USE OF A MATHEMATICAL MODEL TO EVALUATE THE HYDROLOGICAL EFFECTS OF LAND-USE CHANGE**

**K. J. Langford**

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Because the hydrological cycle of hilly terrain is sensitive to land-use change, land managers should be aware of the implications of any change in use. A mathematical model of the hydrological cycle is used to compare the effects of land management options under a wide range of climatic conditions. Variations in simulated response of streamflow to land-use change are analyzed statistically. Five land-use options ranging from complete clearfelling of mixed hardwood and pine forest to the establishment of a low intensity recreational area are compared under nine different climatic sequences for a small experimental watershed in Ohio. Causes for the variation in simulated response of streamflow to the changes in land-use are proposed.

Evaluation of the implications of the changes in streamflow for small rural water supply systems is the final stage of the study. Although the present generation of mathematical models of the hydrological cycle are relatively crude, they still represent the best approach for evaluating the hydrological effects of land-use change.

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#### **FEDERAL-STATE COOPERATION ENCOURAGES MULTIPLE USE MANAGEMENT OF PRIVATE FOREST LAND**

**R. F. Watt**

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Although the Northeastern States have great population centers, nearly 70% of the area is forested. Forest lands are concentrated on the steep, rocky, infertile soils unsuited for farming. Three-quarters are held by non-industrial

owners who have little knowledge of multiple use opportunities. Because of proximity of these forests to markets and population centers, they are valuable for recreation, timber, wildlife and watershed uses, but, due to past abuse, produce far less than their potential. The Federal and State Governments are cooperating to reach these owners and increase the contribution of their lands to the national welfare. The State and Private Branch, U. S. Forest Service, provides financial aid to the States to fund foresters and other professionals who give on-the-ground assistance to landowners. The Forest Service offers technical assistance to the States, transmitting latest advances in applied research in fields related to forest land management. Research needs, developed by the States, are made known to the Research Branch, U. S. Forest Service, for consideration in its program. Financial incentives encourage the landowner to adequately manage his lands. Tax advantages under State and Federal laws and partial payment of the costs of non-commercial operations to improve the forest are available. Unfortunately, these programs are still not sufficient to reach all interested private landowners, as is attested by the backlog of unanswered requests in all States.

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## 127 MULTIPLE USE MANAGEMENT OF WEST VIRGINIA HILL LAND

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The hill land of West Virginia lends itself to many uses. There are some residential tracts on Class IV land (Westover Interchange, e.g.); there are large undisturbed forested tracts on hilllands (Cathedral State Park, e.g.); there are areas that have been cut that are used for grazing (Wade's Run pastures, e.g.); and there are vast tracts of land that are used for recreational purposes (Dolly Sods, Otter Creek). The most ambitious of the state-sponsored hill land recreational developments is Cass Scenic Railway. Appalachian Motorcycle Raceway is an example of an ambitious commercial enterprise utilizing hill land. Nearby Alpine Village is an example of a combined recreational and habitational settlement. The aesthetic appeal of hill land leads many people to want to live here: to enjoy the scenery, the wildlife, the seclusion.

In terms of spreading the appeal of hill lands, the state of West Virginia sponsors a number of parks and forests, notable among them for dramatic land usage are Pipestem, Blackwater Falls, and Watoga. The Monongahela National Forest is the most important example of multiple use management of a hill land area in West Virginia, comprising over 1 million acres.

Commercially, the richest return on hill land usage is residential development. Commercially developed agricultural and forest usages rank second, recreation third, and fourthly comes private usage, which may have no economic return at all. To the politician or the economist or the scientist, there is a danger of overlooking the aesthetic appeal of undeveloped hill land: but we are constantly reminded of this by those Appalachian peoples who know and love their land, are knowledgeable about its flora and fauna, and would not move from it unless forced to do so. The aesthetic appeal of the hill land may have no monetary return: so of all the multiple usages, it alone may need special protection and understanding.

(This paper will be illustrated with appropriate slides and tables).

Eugene C. Bammel, Ph.D

College of Agriculture and Forestry

Division of Forestry

## 128 MULTIPLE CROPPING IN SOUTH KOREA HILL LANDS

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South Korea's population demands highly efficient land utilization for food production. The frost-free season varies from about 150 days in northern to 250 days in southern provinces, with upland utilization indices from only 125 to over 200 respectively. The rugged, granitic slopes are difficult agricultural challenges, for any intensive farming of food crops. Major constraints include economic pressures from rapidly increasing land and input costs, commodity price relationships, and technical limitations of fertility, slopes, water, pests, and cultivar maturity and cold tolerance. Most common crop systems are; (1) winter grain/soybean, (2) potatoes/corn/pulses mixed or intercropped, (3) winter grain or forage/potatoes, (4) barley/vegetable/potatoes, (5) potatoes/vegetables or pulses, and (6) barley/cotton or tobacco. Recent research and demonstrations indicate that refined systems with new varieties, inter- and mixed cropping with adequate lime and fertilizers, and improved water and erosion control practices can increase production and net returns up to 50% or more over current practices in many areas. Progress has been commendable, but much more research and extension support is needed to evaluate alternatives for natural, and re-formed hilllands. In 1975 at least 400,000 has. of cultivated hillland (moderate to steep-slope upland) was only single-cropped, a significant potential for additional food production in South Korea.

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## 129 DAIRY BEEF PRODUCTION IN THE GUATEMALAN HIGHLANDS

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A beef production system has been developed using Holstein calves in a typical Guatemalan highland region where the main crop is corn. The system is applied in combination with corn grain production and with maximum utilization of corn stover and corn silage as forages. The animals are kept in corrals or pens during the following stages.

a) Artificial rearing of calves, from one week to four months of age. Calves are weaned at eighth weeks of age. They consume a total of 168 lts of whole milk produced from dairy cattle in the farm, 232 kg of a starter and 70 kg of a mixture of 80% ground corn stover and 20% molasses. The starter is a low cost concentrate made from local industrial by-products containing 16% crude protein (CP) and 2.7 Mcal/kg digestible energy (DE). Average daily gains (ADV) vary from 0.4 to 0.5 kg, and liveweight (LW) at the end of this stage, from 90 to 100 kg.

b) Growing of calves, from four to twelve months of age. A mixture of 80% chopped corn stover and 20% molasses is fed ad-libitum and supplemented with 2 to 3 kg/animal/day of a concentrate containing

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\*Author to present paper

25% CP and 2.8 Mcal/kg DE. ADG goes from 0.6 to 0.8 kg/day, and LW at twelve months, from 240 to 270 kg. c) Finishing of steers, from twelve to eighteen months of age, when they reach slaughter weight. Corn silage is fed ad-libitum and supplemented with 3 to 4 kg/animal/day of concentrate. ADG varies from 0.8 to 1.0 kg, and LW at eighteen months, from 400 to 440 kg. The number of animals that can be fed annually from the corn silage and corn stover produced/hectare/year is 8 and 4, respectively. Economic studies indicate that the system could be applied successfully in farms of at least 10 hectares in similar areas of Central America.

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## 130 BEEF PRODUCTION ON SLOPING LAND IN SOUTHWESTERN WISCONSIN

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Permanent pastures play an important role in midwestern agriculture, even in this age of mechanized stored feeding. This is particularly true on Upper Mississippi Valley livestock farms with land suitable only for limited cultivation. Such is the situation on the unglaciated Fayette-Dubuque and associated soil types in southwestern Wisconsin, northwestern Illinois, northeastern Iowa and southeastern Minnesota. Much of this 12-1/2 million acres should remain in permanent vegetative cover for pasture, woodlands or wildlife preserves according to a United States Department of Agriculture conservation needs survey. There are approximately 1.9 million acres of permanent pastures in Wisconsin alone. Most of this is on highly eroded, moderately steep to very steep slopes; over 1 million acres, or 55% with slopes of 6 to 30%. This can be improved by renovation without serious soil loss and with favorable economic returns. A large portion of the 500-acre University of Wisconsin agricultural experimental farm at Lancaster in southwestern Wisconsin is devoted to research with forage crops and pastures. Research has been conducted, since 1966, on renovated pastures under the cooperative leadership of pasture research personnel from the above four states. During the 1967-1970 period, grass-legume pastures produced an average of 315 pounds of beef/acre while the same grasses with 120 pounds of nitrogen per acre produced 311 pounds. Renovated grass pastures, without added nitrogen produced 205 pounds. Extending the pasture season by grazing stockpiled early fall growth and increasing nitrogen rates to 200 pounds per acre increased yields to 474 pounds per acre during the 1972-1974 seasons. Each year daily gains were below 1.5 pounds; most cattle did not grade high enough at slaughter time. Apparently, cattle consuming high quality pasturage did not consume enough dry matter to meet their energy needs. A study begun in 1975 is evaluating feeding limited amounts of corn grain on pasture. Results of two pasture seasons will be presented.

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## 131 PASTURE MANAGEMENT AND BEEF PRODUCTION IN THE SOUTHERN PIEDMONT

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The Southern Piedmont region of the Southeastern U.S.A. comprises a rolling upland plateau lying between the Blue Ridge Mountains and the Coastal Plains. The climate is mild and humid, and favorable for a diversity of agricultural crops. Erosion has been severe over much of the area, and a high proportion of the land area requires conservation practices, fertilization, and liming to establish and maintain productivity. Land use has been greatly affected by industrial development of the area with its opportunities for non-farm employment. These factors have encouraged expanded beef production. This paper reports a portion of the pasture research conducted at the Southern Piedmont Conservation Research Center during the period 1972 through 1975. Three Kentucky-31 tall fescue, *Festuca arundinacea* Schreb., pastures, two Coastal bermudagrass, *Cynodon dactylon* (L.) Pers., pastures and one Coastal pasture interseeded with tall fescue were grazed with Angus brood cows the year around from 1972 through 1975. The three fescue pastures, stocked at .4 ha/cow, were fertilized at three N levels: high N (supplied by broiler litter at a mean level of 15.68 metric tons/ha per year), moderate N (224 kg N/ha per year as  $\text{NH}_4\text{NO}_3$ ) and low N (74 kg N/ha per year as  $\text{NH}_4\text{NO}_3$ ). The two Coastal pastures were fertilized at two different N levels supplied by  $\text{NH}_4\text{NO}_3$ ; moderate N (280 kg N/ha per year) and low N (20 kg N/ha per year). The low N Coastal was stocked at .81 ha/cow and the moderate at .4 ha/cow in 1972 and adjusted to .27 ha/cow in 1973 through 1975. The Coastal-fescue combination was stocked at .4 ha/cow and fertilized at 149 kg N/ha per year. Mean adjusted 205-day weights for the four-year period were 165, 167, 162, 172, 185, and 178 kg for the high N-, moderate N-, low N-fescue, moderate N-, low N-Coastal and the Coastal-fescue combination, respectively. Mean adjusted kg calf/ha were 372, 376, 380, 576, 225, and 433, respectively. In an effort to increase calf weights beyond weaning levels, calves were grazed for 140 days during the winter-spring period on tall fescue, rye-temporary pasture-fescue, and rye (*Secale cereale* L.) interseeded in dormant Coastal bermudagrass. Mean kg liveweight gain/ha were 206, 259, and 296 for these three treatments, respectively. Results will be discussed in relation to forage production potentials of the region.

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## PASTURE PERFORMANCE OF BEEF COWS AND CALVES GRAZING ORCHARDGRASS, TALL FESCUE AND TALL FESCUE-LEGUME HERBAGE

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Hereford cows and nursing calves were used to evaluate the effect of grazing orchardgrass (*Dactylis glomerata* L.), tall fescue (*Festuca arundinacea* L.), and tall fescue-legume (*Trifolium* sp.) swards on animal performance. Liveweight gains of cows and calves and conception percentage of cows were measured. The experiment consisted of two field replications and was conducted at the Southern Indiana Purdue Agricultural Center. Each 10 ha paddock was grazed from late April until early October in three consecutive years. Tall fescue and orchardgrass pastures were each fertilized with nitrogen at 168 kg/ha in early spring of each year. Grazing pressure was regulated by harvesting hay on a portion of the pastures during periods when herbage production exceeded animal consumption. Calf liveweight gains (kg/day) averaged 0.80, 0.58, and 0.83 for orchardgrass, tall fescue, and tall fescue-legume, respectively. Cow liveweight gains (kg/day) and conception percentage averaged 0.32 and 90, 0.05 and 72, 0.31 and 92 for orchardgrass, tall fescue, and tall fescue-legume pastures, respectively. Legumes accounted for approximately 30% of the herbage dry weight in the tall fescue-legume pastures.

\*Author to present paper

Net dollar return/ha for orchardgrass and tall fescue-legume exceeded that of tall fescue by \$77 and \$120/ha, respectively.

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### MANAGEMENT SYSTEMS FOR SHEEP AND LAMB PRODUCTION ON HILL LAND

J. M. Lewis,\* F. C. Hinds, H. A. Cate, M. E. Mansfield, and G. E. McKibben  
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The University of Illinois Dixon Springs Agricultural Center is located at 37° 30' N. latitude and 88° 40' W. longitude on rocky, forested hill land of the Ozark uplift. The unglaciated soils, predominately Grantsburg, Zanesville and Wellston silt loams, are subject to erosion. The growing season is 200 days and annual rainfall is 114 centimeters. The research area was reclaimed from abandoned, eroded land by correcting fertility deficiencies and establishing legumes and grasses to increase forage production. Utilization of the high producing pastures required heavy stocking. Warm, humid weather encouraged rapid buildup of internal parasites until usual grazing management and anthelmintics would not provide adequate control on growing - fattening lambs grazed with ewes. Management systems studied included (a) conventional grazing of ewes and lambs on nitrated grass or legume grass mixtures with and without lamb creeps, (b) separation of ewes and lambs during the day with ewes grazing grass or legume pastures and lambs confined to drylot with ad lib feeding or grazed on high quality legume pastures - lambs and ewes were together in the barn at night, (c) lambs weaned at 60 days (EW) and confined in drylot with ad lib feeding or grazed on grass or legume pastures with complete diet available. EW lambs or lambs grazed separately from ewes gained rapidly and did not become infected with internal parasites. Harvested feeds per kg of gain varied from 2.8 to 5.3 depending on system used. Early weaning permitted more complete utilization of forages by ewes and gave impetus to developing accelerated lambing programs. Lambs allowed to graze with ewes utilized more forage but developed infestations of parasites with increased mortality from parasitism and predations. Diets for EW lambs containing 17% protein and 75 to 90% concentrates proved most efficient. Varying qualities of high and low quality forages including sawdust, at 10 to 20% of the diet did not affect lamb gains. EW lambs can be confined in conventional housing or restricted to 0.37 M<sup>2</sup> of slotted floor space when self fed.

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### PRESENT USE AND DEVELOPMENT POTENTIAL OF HILL LAND IN IRELAND

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Grazing intensities on hill land are shown for sheep and cattle, and the geological, edaphic and botanical factors affecting their distribution discussed. Mixed grazing systems gave higher animal production than either sheep or cattle alone due to better pasture control and increased utilisation. Liveweight gains of 0.7 kg per head per day were achieved with single suckled cows on a Molinia-Narvus-Agrostis hill. Supplementary feeding of hill ewes gave the best economic return when it was confined to the section of the flock

\*Author to present paper

in poorest condition. The economic and social factors likely to influence future hill land use in Ireland are discussed.

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### **RESPONSES IN OUTPUT ACHIEVED FROM IMPROVED SYSTEMS OF HILL SHEEP PRODUCTION**

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The development of improved systems of hill sheep production in the Hill Farming Research Organisation has been based on the integration of improved pasture with the natural hill pastures in such a way as to obtain the maximum nutritional impact during lactation and during the pre-mating and mating period. Improved nutrition during late pregnancy has been obtained by the use of purchased cereal/protein supplements.

The results of two projects existing in widely different soil, vegetation and climatic conditions in Scotland will be presented.

The first project is based on land in the southern uplands of Scotland in the Cheviot range of hills. It extends to 283 hectares ranging in altitude from 300-900 metres and is stocked with Cheviot sheep. Thirty five percent of the area carries an *Agrostis-festuca* or bracken covered *Agrostis-festuca* vegetation, the remainder is grass heath dominated by *Nardus* and *Molinia*. The average annual rainfall is 900 mm. The second project is on land on the eastern shore of Loch Fyne in the West of Scotland. The area extends to 450 hectares and rises from near sea level to 680 metres and is stocked with Scottish Blackface sheep. Most of the hill is covered by blanket peat and the vegetation is dominated by heather (*Calluna vulgaris*), drawmoss (*Eriophorum vaginatum*), deer grass (*Trichophorum caespitosum*) with some *Molinia*.

In both projects stock numbers have been increased by over 50%; the output of lamb has more than doubled and the output of wool has increased substantially.

The effect of the improved systems of management on the output of weaned lamb and wool and their interrelationships, will be discussed with reference to the changes in the level of inputs made in the two projects.

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### **GRAZING AND PASTURE MANAGEMENT TRIAL OF COOS COUNTY, OREGON, USA**

**L. Cannon**

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Hill land subclover-grass pastures of southwestern Oregon have the capability of producing over 5,000 kilograms of dry matter per hectare annually when soil nutrient deficiencies are corrected. Application of phosphorus, sulfur and molybdenum fertilizer has made it possible to reach this level of production but grazing and pasture management systems to best utilize and realize a profit from this production are not well defined. A stocking rate trial was established on four hectares of undeveloped red hill soils in Coos County in 1970. The area was planted to Mt. Barker subclover and Linn Perennial ryegrass in October of 1970 and then sub-divided into four one hectare subpastures. Each subpasture received molybdenum at a rate of 420 grams per hectare and two subpastures received 20 kilograms of phosphorus and 25 kilograms of S per hectare, while the other two received 40 kilograms of phosphorus and 50 kilo-

\*Author to present paper

grams of sulfur per hectare. Grazing intensity was applied at 2 rates, 3 ewes per hectare on two subpastures and 6 ewes per hectare on two subpastures. The grazing intensity was arranged so that each grazing rate was applied to both levels of fertilizer application. At the grazing intensity of 3 ewes per hectare, 124 kilograms of lamb per hectare are produced and at the 6 ewes per hectare 226 kilograms of lamb per hectare are produced. Complete control of bracken fern and wild blackberries was achieved in pastures grazed at the 6 ewes per hectare rate and the forage in these pastures was well utilized. In the lighter stocked pastures (3 ewes per hectare) some forage was not utilized and weeds invaded the pastures. After four years operation of the trial it is apparent 5-7 ewes per hectare can be carried on hill pastures in Coos County when proper fencing and pasture fertility are maintained. At the stocking rates used, there was no apparent advantage of applying more than 20 kilograms of phosphorus and 25 kilograms of sulfur per hectare annually once the subclover and grass were established.

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## APPENDIX

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The nature of New Zealand's hill country and its development from pre-European vegetation to pasture is described. Problems encountered in this development are outlined and research efforts, especially since 1920, have been briefly discussed.

The agricultural potential of this land has been assessed as equal to that of adjacent lowland, but future development will be dependent on national planning based on biological, economic and social factors.

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The form of economic organization which prevails in most Mexican villages, particularly in hilly, eroded or poorly-watered areas, is peasant farming. It has been so since the Spanish Conquest and even before, and although the national economic and political system has varied, as has the way the peasant product and producers were linked to and exploited by the system, the peasant farm has retained through time the essential features of its inner organization. The peasant farm is a production, as well as a consumption and residential unit. Usually established on a kinship basis, it owns or possesses its land, and mainly applies its own labour force to it. As a rule, the peasants use no or very little hired work, and then only for technical reasons, since they aim at their own subsistence and reproduction, rather than profit. In Mexico, the access to land is usually dependent upon the peasant's belonging to the community. Each farm is autonomous, however, and has no organic link with its neighbours. This form of economic organization has proved to be quite steady and lasting, unlike the varied political superstructures which have been associated with it in different times and places. In fact, these organizational features refer only to the production and distribution sphere, as the peasants have no social organization of their own beyond the municipal boundaries; instead they have always been politically subdued, and economically exploited. The 1910 Revolution in Mexico represented a major change in the relationship between the peasantry and the dominant system and classes, which had previously been characterized by tribute during the 1st part of the Colonial epoch, followed by a mercantile-feudal system based on the hacienda. With the Agrarian Reform (1917), the peasants had most of their lands restituted, and were able to resume their productive activities according to their own organizational patterns. The finality of their production is nevertheless determined by the needs of the capitalist economy of which they are an integral but dominated part. It thus appears that the peasant economy expresses a situation inherited from the pre-revolutionary times, with the peculiarities of its organization being re-interpreted and used by the capitalist system for its own sake. In my paper, I further develop this argument, and present criteria which make evident the geographic and socio-economic divisions between capitalist and peasant agriculture in Mexico today.

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