practical education and expand the administrative training. Greater responsibility for gaining practical experience and skills could be placed on the student by the college. The college advisor could assist by providing an approved check-list of projects that develop practical ability.

It is logical that the range student should spend his college time studying sciences he can not learn on the job. College would be more effective if it were to confine itself to fundamental scientific education and training in business administration. Practical experience and applied administrative education could be more effectively acquired before and after graduation as a part of on-the-job training.

---

Range Management: Objectives and Training

AMRAM KADISH
Graduate Student, Department of Botany, Univ. of California at Los Angeles, Los Angeles, California

"...a complete and generous education, that which fits a man to perform justly, skillfully and magnanimously."

John Milton, On Education

I came to this country from Israel to study range management and thus have become familiar with its application as well as training objectives in both countries. This paper will summarize my observations of the training objectives of the range management curriculum. Objectives for training cannot, of course, be separated from the application to a particular situation. I believe that range conditions are alike in many ways in California and Israel, particularly because of the similarity in the Mediterranean-type climates of both places, and the natural vegetation. The chief difference between the range situation in Israel and California is the antiquity of the range throughout the Eastern Mediterranean, compared to the youth of that in the western United States, where it is, at the most, only a few hundred years old.

When a review is made of the history of grazing in any one place, a parallel may be found between the chronological sequence of management procedures, as applied to particular situations, and the development of teaching objectives. Thus, the practice of pasture and range husbandry, and the stages in the development of its theory can be divided into four phases:

**Description** of vegetation types; plant communities and their relations

**Management** of the resource (site and resident species) for the optimum of sustained production

**Introduction** of superior forage plants

**Selection and Synthesis** of superior forage plants (using resident, exotic or both)

This division is arbitrary and will not apply equally to every situation, but will depend on the historical status of each. The immediate objectives of training will vary in the same way. Since this division is arbitrary, a certain degree of overlap is inevitable. One’s work is never limited to any single phase. Yet rarely, if ever, will anybody find need to divide his efforts among all four. Nevertheless, when planning a range program, we should consider the whole picture. The first phase, describing and assessing the range resource, is carried on as soon as a territory is opened to settlement. Vegetational types can be determined in a practical manner by the settler, who is followed by the administrator and the botanist. The latter study the vegetation extensively and their results are summed up in the form of a workable map of the types. Further intensification of human activities, particularly of an agricultural nature, calls for more detailed analysis of vegetation. At this point sub-types and plant communities of various magnitudes are defined. For instance, the soil-vegetation survey currently carried on in California can justly be classified under this category. This first phase, in general, is regarded as an inventory.

The onset of the second phase, that of management, practically coincides with that of the former; i.e. the settler and his beasts arrive simultaneously. It is assumed that the vegetational types which a settler finds are in a stable ecologic equilibrium in the pre-settlement environment. However, the introduction of new environmental factors will obviously disturb this balance. The disturbances brought about by human activities will be reflected in the biota, i.e., soil, flora and fauna. The attainment of a new equilibrium depends on the extent of human activities, such as grazing pressure and management practices. Before this new balance is reached, some soil changes will have taken place, botanical composition will have changed and, similarly, various components of the original fauna will have been altered. American rangemen are well aware of problems of management and no further elaboration is required at this point.

The third phase of introduction may start with the settler but will increase in importance as settling activities become intensified. It is safe to generalize that man selected his crop plants and transported them along with his beasts from time immemorial. These crops were subjected to constant, though unintentional, selection, i.e., the heavier
seed producers among the cereals were favored while in the pasture the more grazing-resistant types had a definite advantage. Along with the crop plants, weedy types found a suitable environment, turning into permanent companions to man's crops and thus becoming an integral part of this human environment.

The list of plants introduced intentionally and accidentally to the United States is staggering. On first look, one would assume that the United States has been settled long enough to allow for a fair introduction of forage plants, as well as weeds, from the older centers of civilization. However, my short stay has convinced me that we are only in the beginning stage of plant introduction for dry ranges. As an example, we can site the amazing performance of Phalaris spp. on California ranges within the last few years. None the less spectacular are the annual clovers—such as rose clover (Trifolium hirtum) and subterranean clover (Trifolium subterraneum). Among the weeds which have spread alarmingly in recent years, medusa head (Elymus caput-medusae) is probably the most outstanding.

The last phase, selection and synthesis, would make use of the advances of systematics, plant physiology and plant breeding. It is associated with the more advanced and intensified stages of agricultural activities. This phase has come to be of considerable importance in recent years, particularly in Europe, New Zealand and Australia. However, little more than the surface has been scratched. The potentials of improved forage crops are doubtless very great if we can judge from the progress of other agricultural crops. Cereals, for instance, have been under a program of continued selection for hundreds of years, yet they are still found worthy of further improvement. Besides, new concepts and recent advances in plant physiology, systematics, cytology and genetics have revolutionized our ideas of the potentials of this group (i.e., intergeneric crosses, recurrent selection, and the use of heterogenous strains of hybrid source instead of the conventional "pure line" varieties).

The aforementioned phases are emphasized in the practice of range management at successive stages in the development of the agricultural economy in general and the livestock industry in particular. Each of the succeeding phases mentioned calls for a more intensive management and is justified when higher land values are at stake. While the four phases may be recognized from their historical-chronological relationships, a still further spatial distinction may also be recognized. Thus, localities situated near high populated centers will command a higher dollar-value, and consequently, will justify more intensive management practices. At the same time, the farther outlying districts will not warrant anything but inexpensive measures.

A third basis of comparison between the four phases is that of the amount of time required for completing even preliminary investigations, and obtaining positive and applicable results. Inventory, being a survey type investigation, can be carried out in a relatively short time, depending on the intensity of the study. At the other extreme is the fourth phase, that of selecting and synthesizing strains, which can have fruitful results only after long, drawn out studies are made, all of which are in danger of bogging down, due to innumerable dead-ends. (This very phase, being new to many of us, deserves further explanation.)

Undoubtedly there is a place for improved or synthetic strains. However, their impact would be fully appreciated and acknowledged.

---

### Table 1. Tentative training program for the four phases of range research (arranged cumulatively).

<table>
<thead>
<tr>
<th>Research Phase</th>
<th>Administration</th>
<th>Inventory and description</th>
<th>Resource management</th>
<th>Plant introduction</th>
<th>Plant breeding and selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Animal husbandry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
after full advantage has been taken of the improvements and the incorporation of available exotic forage plants. Be that as it may, studies of the fourth phase are a long-time proposition. (The practical applications, if and when they are made, might be incidental to the theoretical merits of this research). When applied in the ripeness of time, they may give results that can be immediately incorporated and utilized and be of considerable value to pasture and grazing husbandry.

Intermediate in nature are the phases of management and introduction. At times, both may be investigated either simultaneously or in toto. In some aspects of management, results obtained from short range experiments can be put immediately into practice. Later, as results of the long range studies become available, they are applied respectively.

A more frustrating field of endeavor is that of introduction, where innumerable accessions are often tested before any useful plants are found that are suited to the conditions at hand. This phase helps in various aspects of management by either increasing the general forage production or alleviating a seasonal shortage, or both. Personal experience indicates that successful introduction is probably more of an art than a science. Art, indeed, it is; because we still are not able to keep or summarize all the ecological data pertaining to any accession on IBM cards. Hence, keen observations and intuitive selection for a given site, may mean the difference between failure, routine work and success.

Once the results of research have been successfully applied and integrated into the general practice, they are often taken for granted as though they had always been used. The "sagebrush type" and "tall grass type", for example, have become common terms in the farmer's vocabulary; range fertilization or rotation grazing are gaining support from practice. In many regions the planting of crested and intermediate wheatgrass is a common practice, while the use of Sherman bluegrass is spreading in the localities where it is adapted.

But the danger of taking matters for granted is that it may preclude the possibility of a re-examination which would shed a different light on a situation, leading and pointing to dissimilar and, at times, contrasting conclusions (which many of us are not willing to acknowledge and accept).

In training we distinguish between administrators and research workers. The first are responsible for administering and managing properties. Their objective is usually that of maximizing sustained production by the use of current management practices. The second group undertakes investigations aimed at improving and raising the carrying capacity and productivity of pastures.

In light of our discussion, what should be the training of both groups? It is obvious that the first group is trained basically as farmers of today, to manage agricultural property in a competitive market. Business principles as well as agricultural know-how underlie their activities. The present discussion is far more concerned with the second group. Here emphasis should lie on the needs of budding scientists. On what possible phases are they going to concentrate in their future research work? We can assay the requirements of each region and the investigations for the coming five, ten, twenty-five and thirty-five years. This is the period during which most of the graduating scientists of today will be engaged in active research. One could terminate the discussion at this point, letting the concerned reader form his own views and tentative program. However, as an example, a possible classification is presented in Table 1 which categorizes the nature of each of the four phases by their respective requirements.

One may find that while the training for the first phase may be covered satisfactorily in the regular curriculum, further training might be required for later phases of range research. This is by no means new or surprising. Yet the fact remains that successful research careers and worthwhile achievements call for somewhat broader training and a wider background than that ordinarily recognized in many instances. This training program might very well be at the expense of the so-called "advanced" ecology and grazing management which can be more profitably gained out in the field.

We are not being given all the answers in our training, but it provides an ideal foundation—as outlined above—and will provide us with the incentive and tools to solve our needs. As Holmgren has so aptly put it:

"While man has a creditable record of achievement to look back upon, he still has to come to work more with Nature, for he cannot control her. Only then will he be able to use and enjoy the great endowments of her resources which have come to his heritage."

ACKNOWLEDGMENT

To the following I am indebted for a critical review of this discussion: Dr. C. Epling, Univ. California at Los Angeles; Drs. H. H. Biswell and A. M. Schultz, Univ. California, Berkeley; Dr. R. G. Stanley, Calif. For. & Range Exp. Sta., Berkeley; and Dr. R. M. Love, Univ. California, Davis. Many of their suggestions were included and are gratefully acknowledged.

I am particularly appreciative of the assistance kindly rendered by Miss S. Lyman in editing and prompt typing.