HARVESTING BEFORE THE FIRE FOR ENERGY; MEDITERRANEAN-TYPE ECOSYSTEMS IN GREECE. COSTS AND BENEFITS

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Contract number : ESE-R-063-GR(B)

Duration : 30 months, 1 January 1982-30 June 1984

Total budget : DRA 11.463.000 CEC Contribution: DRA 2.865.000

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Summary

Harvesting natural mediterranean-type ecosystems as a managemental policy to provide energy and organics and at the same time face the fire problem demands first answer to questions dealing with its ecological soundness. It was found that the system recovers very well after harvesting, in a similar way to that after a fire with a significantly increased net productivity. The losses of nutrients due to biomass removal are compensated in a ten-year period when nitrogen is concerned, whereas the same is not valid for phosphorus. Because of the herbaceous bloom in the first post-harvesting years and the resprouting behaviour of the woody plants the soil subsystem continues to be replenished in carbon and energy. The diversity of the system increases and new habitats and niches are created. It is concluded that such a managemental policy is both profitable and ecologically sound.

1.1 Introduction

It seems that energy from biomass is not the panacea for solving energy and environmental problems. Without any doubt utilization of agricultural and animal residues for energy production may be used to some degree to face the energy and environmental crisis; on the other hand proposals dealing with energy crops as well as with cultivation of "marginal" lands are not free of ecological problems. Referring to energy crops, the questions arising concern competition for agricultural land, and all the problems relating to conversion of natural to man-made fragile systems such as the need and impacts of pesticides, insecticides and fertilizers use. On the other hand utilization of marginal lands for the cultivation of species like jojoba and guayule (1) is not necessarily acceptable from the ecological point of view. The word "marginal" has any sense only from the economic point of view since such lands, mainly in the semi-arid regions of the world are often very important because they represent an invaluable pool of genetic information.

Despite the above mentioned shortcomings of biomass utilization, we believe that there could be found solutions ecologically sound. Natural ecosystems have the advantages of covering extended areas of the Earth being highly resilient at the same time, able to absorb perturbations. By following basic ecological theory the limits of their resilience could be estimated, and if so we could further proceed to a profitable exploitation without degradation.

On that basis we started this project; systems proposed for exploitation are the mediterranean-type ecosystems of Greece (2, 3, 4). These systems are attacked by frequent fires with resulting loss of valuable energy and organics. Since they are adapted to regenerate after fire the basic idea of this project lies to the possibility of fire substitution by harvesting. If so, fire hazards are minimized while energy and organics are gained and exploited.

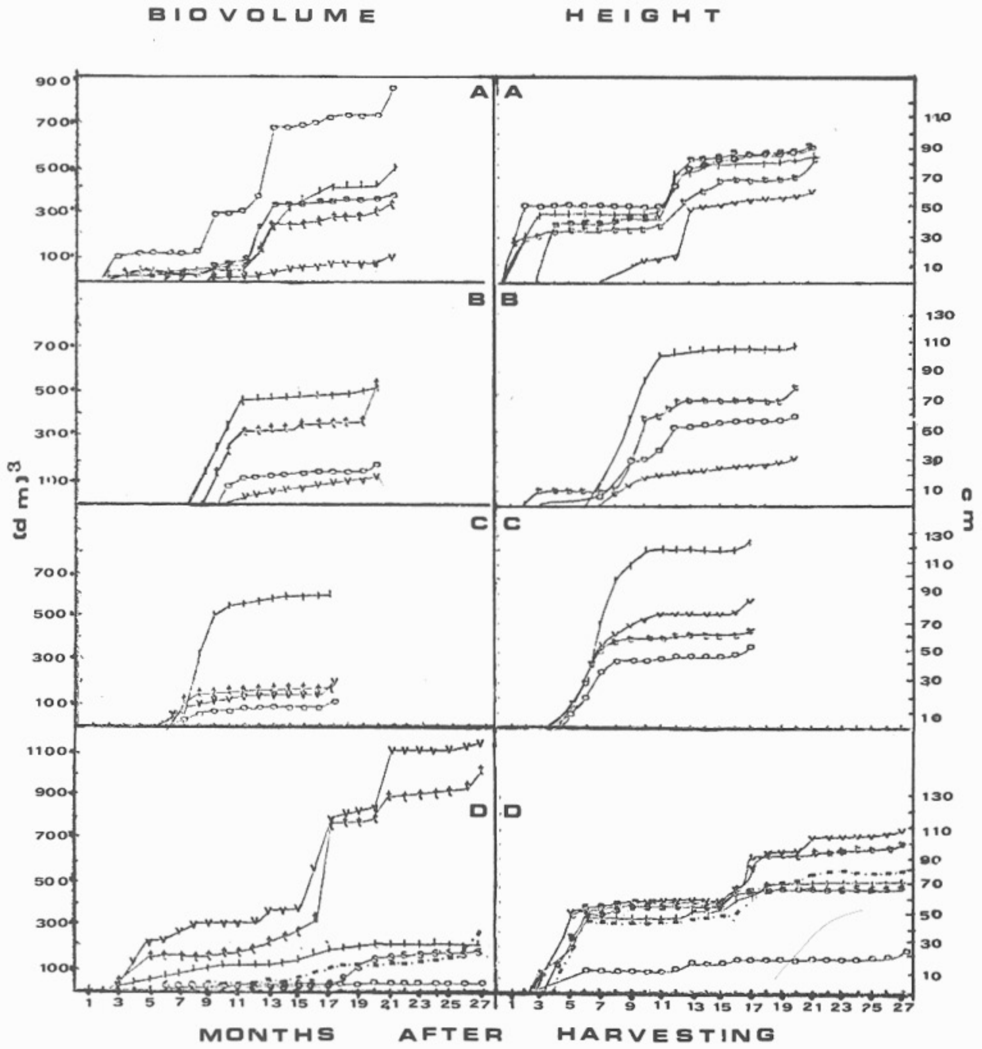
The questions formulating the research skeleton are:

- can harvesting substitute fire?
- which plants can recover?
- is the system's diversity maintained?
- is fertilization necessary in consequence of nutrients removal by harvesting?

1.2 Recovery after harvesting

Figure 1 contains data representing the recovery of dominant plants after harvesting. Diagrams A, B and C concern harvestings in spring, summer and winter. In all cases woody plants recover quite well. Of course during the stress period (summer) the recovery mechanism does not function but after the first autumn rains it starts again and results taken remind the data from mediterranean-type ecosystems recovery after fire (5, 6). We must also point out that even herbaceous plants, absent in the maquis system before harvesting are present afterwards.

As we stated in the last report (7) we chose an area cleared in the past from the National Electric Corporation for installation of high voltage lines. We have already mentioned that recovering of these systems is quite satisfactory. These areas were harvested 18 and 8 years ago and we proceeded to a new harvesting two years ago.Data presented in Figure 1 - Diagram D- show that the dominant plants recover in a way resembling that of stands harvested in the past in terms of species composition and quantity of plant production. Another point of interest is the fact that not only woody plants but also many others such as herbaceous and geophytes, coming always after fire, appear as well (Figure 2). Among the geophytes *Asphodelus microcarpus* dominates. Therefore, it is obvious that these systems react very positively after harvesting without any sign of degradation.



III Phillyrea media

OOO Quercus coccifera

ttt Erica arborea

SSS Olea sp.

—·— Calicotome villosa

VV Arbutus unedo

Figure 1. Recovery of dominant maquis shrubs after harvesting in different seasons (A, Spring; B, Summer; C, Autumn) is very quick. Same is true (D) after the successive harvesting before 18, 8 and 2 years.

Figure 2. This photo shows one year recovery of a harvested system.

Before proceeding to exploitation of maquis ecosystems more data are required deriving from other typical areas, as well. For this reason we started experimental harvestings in Mt. Pelion. In that area harvestings have been carried on by the local population every 15-20 years providing therefore means of comparison. The species composition of maquis systems before harvesting consists of evergreen sclerophyllous shrubs like *Arbutus unedo, Quercus coccifera, Quercus ilex, Erica arborea, Phillyrea media Spartium junceum* etc. Though the species composition of all the harvested areas was not identical, recovery was observed in all cases, and the productivity attained during the first year was more than 14 $tons.ha^{-1}$.

1.3 Productivity characteristics

When a maquis system is aged more that 20 years, the number of the component species is relatively low. A striking feature is the absence of herbaceous plants below the shrub canopy (Figure 3). The biomass of the system remains almost unchanged and all photosynthetic production is directed to maintaining the biological activity. After harvesting productivity is very high. If we compare the green to the non-green aboveground biomass in Mt. Pelion, one year after harvesting, the ratio is 1:1 while before it was 1:20. It is obvious that through harvesting maquis systems are brought back to the early successional stages what means serious increase of net productivity. The theoretical model we presented last year on maquis productivity (7) seems to be valid under field conditions.

1.4 Nutrient losses

It was stated in the last report that carefull estimation of nutrient losses due to biomass removal with harvesting should be elaborated. At least 100 $kg.ha^{-1}$ of nitrogen and 10 $kg.ha^{-1}$ of phosphorus are removed and must enter the system during the next ten years before a new harvesting to keep balance.

For this reason in 1982 we installed raingauges in Stavros experimental site, from which we collected the rain water in order to estimate the quantities of nutrients entering in the system through precipitation. In a one year period (1982-1983) 5 $kg.ha^{-1}$ nitrogen have entered in the system;

Figure 3. Unharvested maquis aged at least 33 years are almost free from herbaceous vegetation. This system is waiting for the next fire while the biomass is almost stable.

consequently we can predict that half of the quantity removed by harvesting will be back in a ten-year period.

At the same time, since the presence of *Papilionaceae* species the first post-harvesting year was great enough, we tried to estimate the quantity entering the system as a result of atmospheric nitrogen fixation by bacterial nodules in their roots. According to our data 3.2 and 0.7 $g.m^{-2}$ are fixed the first and second year, respectively. If these values are added to those referring to precipitation it can be easily seen that more than 80% of the removed nitrogen comes back in a ten-year period. If we further include values of nitrogen fixation by woody shrubs such as *Spartium junceum* and *Calicotome villosa*, occurring in high number after harvesting, we might eventually conclude that there will be no problem of nitrogen shortage deriving from this type of management.

Concerning with phosphorus the situation is not so promising as with nitrogen. From a quantity of about 10 $kg.ha^{-1}$ removed, only 0.3 $kg.ha^{-1}$ came back through precipitation in the first year (1982-1983). That means that with rotating harvesting every ten years only 30% of phosphorus returns through precipitation. If we consider also that our soils are somewhat poor in this element it seems that fertilization with phosphorus will be needed. More data should be collected in the near future in this matter.

1.5 Soil metabolism

Since the energy and/or carbon offer to the soil subsystem might be seriously decreased because of the removal of the above ground biomass it was pointed out in our last report the need to estimate litter fall. It seems after all that such a problem does not exist. The bloom of herbaceous plants appearing during the first two years after harvesting and the resprouting shrubs like *Arbutus unedo, Erica arborea, Cistus* sp., *Calicotome villosa* etc., provide enough material replenishing the soil.

1.6 General remarks

Looking to the harvested systems we can conclude that maquis systems do not suffer from this kind of management. On the contrary, they show an active succession, and the number of plant species after harvesting is relatively high. During the spring of 1982 and 1983 herbaceous plants were in full bloom. The peak coincides with increased numbers of insects, which is reasonable since many of these plants are insect pollinated. It means that by this kind of management we make a complex environment where diverse organisms have the chance to find habitats and niches (Figure 4).

Figure 4. Harvested maquis, from the National Electric Corporation, 8 and 18 years ago, are recovering very well since not only all the plants are coming back but also birds are present.

It should be also taken into account that by such a managemental policy there is no flammable material in the system and therefore there is no more any need for expences for protection from fire. According to our calculations the biomass available for exploitation is high enough and the combination of all estimations and results make us propose this sort of natural systems exploitation which does not harm them but on the contrary efficiently protects them.

1.6 References

1. Goodin JR and Northington DK. (1979). Arid Land Plant Resources. International Center for Arid and Semi-Arid Land Studies, Texas Tech. University, Lubbock, Texas.
2. Margaris NS. (1979). In: Biological and Sociological Basis for a Rational Use of Forest Resources for Energy and Organics (S. Boyce, Ed.), USDA/Forest Service, Southeastern Forest Exp. Stn., Asheville, N.C.
3. Margaris NS. (1981). Biomass, 1:159.
4. Margaris NS. (1983). International Journal of Solar Energy (in press).
5. Biswell HH. (1974). In: Fires and Ecosystems (T.T. Kozlowski and C.E. Ahlgren, Eds.), Academic Press, N.Y.
6. Conrad CE and Oechel WC (Tech. Coordinators). (1981) Dynamics and Management of Mediterranean-Type Ecosystems, USDA/Forest Service, Pasific Sothwest Forest and Range Experimental Station, Berkeley.
7. Margaris NS. (1982). In: Energy from Biomass (Series E, Volume 3, G. Grassi and W. Palz, Eds.) D. Reidel Publishing Co., Netherlands.