IEA BIOMASS PRODUCTION - TASK V

Energy Forestry Production System: The situation in Italy

by

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A B S T R A C T

A brief description has been given on the precarious energy situation in Italy and considerations have been made on the potential and practical possibility of coppice woods as well as of short-rotation intensive culture (SRIC), utilizing poplar and willow trees as energy source.

After having examined the characteristics and problems of poplar cultivation in Italy, which is fundamentally directed to the production of high quality wood for the plywood industry, it has been demonstrated that at the moment SRIC is not economically convenient. Nevertheless research work on the production of biomass utilizing poplar and willow trees in SRIC is being carried out and the results obtained have been given. Moreover, the necessity of continuing experimentations to identify more productive clones, in order to also assess the physical characteristics of the biomass produced and to determine economical cultivation pattern, has been underlined.

Workshop at Lind, Herning, Denmark - May 10th-12th, 1989.

ENERGY FORESTRY PRODUCTION SYSTEM

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INTRODUCTION

Although Italy is one of the most industrialized countries in the world, it has a very serious energy situation, especially within the Community. It has the highest dependence on foreign countries for primary sources (83%), it relies more than other countries on oil (60%), it invests less than the others in new technologies and has recently stopped the industrial development of nuclear energy (Ippolito, 1988).

To meet the serious problems of energy supply, Italy has to resort to energy saving and directs its efforts to a more balanced diversification of primary sources in order to reduce depending on foreign countries.

To reduce the oil consumption, the Energy Plan of a few years ago foresaw an increase in the consumption of coal (from 8.5% in 1980 to 18.4% in 1990), of natural gas (from 15.5 to 18.9%) and of energy from other renewable sources: hydroelectric, aeolian, geothermic, solar energy, and the one coming from biomass. As a matter of fact, in 1987 natural gas reached 21.2% but solid fuel reached 10.1% only (Bianchi, 1988).

As for renewable energies, some important changes have been recently recorded in Italy, particularly concerning the use of geothermic (Larderello) and aeolian energy (Porto Torres). Encouraging progress is being obtained in the field of solar energy too (power plants of Adrano in Sicily and of Lessinia near Verona). On the other hand, the interest on an appliance level for biomass has been very poor.

In this regard there are suggestions, coming from multinational agricultural establishments, that enclose enery consuming megaplants, based on the

systematic use of soft-wheat surplus. However this is generaly refused by public opinion owing to its high polluting power and its unacceptablity from the ethical point of view, considering the problems of hunger throughout the world.

On the contrary, the public opinion brings up the subject of biomass more frequently. This is represented by agricultural waste (wheat- and rice-straw, corn-stalks, residues from pruning, etc.), by residual materials in forestry, by solid urban waste, and the possibility of effecting ad hoc crops on waste-lands (for instance Kenaf, Jerusalem artichoke), energy crops (sugar-beet and sugar-sorgho) and plantations of woody plants with fast-growing species, obviously in situations where these plantations are not in competition with food production.

These biomasses, by means of direct combustion, pyrolisis, gasification, liquifying, or anaerobian digestion, can be transformed into higher grade fuel (solid, liquid or gaseous), into electricity or heat.

It must be pointed out, however, that in Italy, in spite of an energy dependence of 83% of the total primary sources in 1987, and with a tendency to grow still more in the following years, the use of biomass as energy source is still negligible, and we cannot forsee the possibility of it representing in the future an actual alternative to fossil and nuclear resources.

Particularly, with regard to the forest systems for energy production, we must say that although fuel-wood represented a very important source of energy in the recent past, it has not been used for several decades. The abandonment of this renewable source, which followed the development of modern economy, is due to its characteristics which are not fit for the realization of centralized and efficient energy-systems at one's disposal, as well as to the fact that the available quantity was absolutely inadequate to meet the increase in home comsumption.

In order to investigate the reason why biomass is not used on a large scale in Italy, it is necessary to consider the characteristics of each of the two possible sources:

- conventional woods, with a special view to coppice;
- short-rotation intensive culture (SRIC) of woody plants.

CONVENTIONAL ITALIAN WOODS WITH PARTICULAR REGARD TO COPPICE

According to the National Forest Inventory (1985), the total forest area is 8,675,100 hectares, 25% of which is high forests, 42.3% coppice, 3.3% specialized timber crops including poplar stands, 24.9% particular stands (for instance mediterranean "Macchia") of low productive value, and 4.3% temporarily bare areas.

In lowlands we find only 2.7% of coppice and 3.4% of high forests, but considering altitudes up to 500 m, the areas of the former increase up to 37% and those of the latter up to 16.7% of the total area. The coppice also prevails between 500 and 1,000 m (46.5% against 28.7% of forest), while at higher levels high forests prevail with 32.7% against 15.7% of the coppice between 1,000 and 1,500 m and with 21.8% against 1.18% above 1,500 m.

Logging is easy on about 60% of the areas supporting high forests as well as coppice, averagely difficult on 26.5% and 27.8% and difficult on 12.9% and 11.5% of the areas respectively.

In public-owned areas, high forests are common (51.7%), while in private areas coppices are predominant (75.2%) and, in particular, chestnut (93.3%), turkey-oak (80.6%), holm-oak and cork-oak (60.8%), bay-oak, Quercus pubescens and Q. pedunculata (80%) and hornbean (69.1%); only beech coppices are frequent in public-owned properties (55.2%).

The annual consumption of woody products is about 35 million cubic meters out of which more than 24 million are represented by roundwood, consumed by industries; the difference is represented by salvage (paper and cardboard) and pulp for paper.

Wood production of home forests is about 7-8 million cubic meters, and the annual utilization of wood from coppice for energy use is around 3 million cubic meters.

Timber import is the third passive item (after oil and meat) of the commercial balance. The home production of wood is inadequate especially in the sector of sawn timber and of the wood needed for the production of mechanical and semi-chemical pulp and, above all, of cellulose for paper and textile.

According to recent studies (Castellani, 1981), by improving the silvicultural system, timber production from forests could reach 11 million cubic meters: 2.6 million cubic meters could be drawn from high forest by final felling and thinning, and 700,000 cubic meters by tending felling and thinning; 2.8 million cubic meters from the coppice in utilization and 500,000 cubic meters from the coppice in preservation; 3 million cubic meters from aged coppice and 1.4 million cubic meters from felling out of forests. Thus, estimates of the potential possibilities of coppice indicate that the quantites of wood could be doubled.

In Italy, at present, coppice is managed according to different lines which are, in some ways, contrasting:

- maintaining the management as a coppice;
- converting the coppice into high forest.

The private owner tends to maintain coppice, because this cultivation pattern guarantees the continuity of production and the realization of a modest income in a relatively short period. Moreover, natural regeneration makes this kind of management very simple.

On the other hand, the forester supports the necessity of converting coppice into high forest, since he believes that this type of management allows the forest to accomplish more efficiently the functions of production and protection. This means he tends towards a forest policy of wider views, where collective interests are of absolute predominance in the use of the forest.

As for the possible utilization of wood from coppice, an accurate survey has been recently carried out on the transformation of small-size or poor-quality timber into various assortments, and especially into boards which can replace massive wood. In this connection, the question concerns both foresters and manufacturers. The former are favourable to supply industry with poor material which, after the abandonment of charcoal burning, remained unused; the latter are in a condition to dispose of very good material for serial working, both for its homogeneity and for its big surface sizes, with a lower price than massive wood.

The problem concerning the possibility of re-utilizing fuel-wood, surrogating large amounts of hydrocarbons by wood, charcoal or their by-products, has been discussed at length during the last few years as a consequence of the energy crisis and deserves a separate discussion. For instance, there is no doubt that in mountain areas or in farms provided with coppice stands, burning wood in modernly equipped plants can save gas-oil, both for heating and for vehicles; but to believe that the use of fuel wood can significantly affect the National energy balance could be a dangerous illusion. One should consider the following two aspects in order to understand the problem. The first concerns the nature of the material to be burnt: it comes from undergrown coppice and waste which, as a whole, are very bulky but of little weight, almost always with a high moisture content; it is available in scanty amounts, scattered over large areas belonging to a great number of owners. As a consequence, the gathering of this fuel-wood is extremely heavy and needs consumption of energy: in many cases this consumption is higher than the quantity of energy obtained by burning (or by the desired "liquefaction"). The second aspect concerns the impoverishment of soil due to the removal of forest waste (small branches, tops of trees, leaves, splinters, etc.) which contributes to the cycle of natural transformation and recovery of soil fertility is essential.

In short, the factors limiting the possibility of extending the use of wood for energy supply are:

- the difficulty of access to coppice stands;
- the fragmentation of ownership;
- the high utilization and transportation costs, therefore the use of coppice wood is limited to a short radius of the cutting area;
- the impoverishment of soil.

Under the present conditions in Italy, ample programs for developing the industrial use of coppice-wood for energy are not advisable.

Therefore, the use of such material by local communities (schools, hospitals, factories, etc.) could be stimulated only near areas with a high production potentiality of coppices, far from transforming industries.

SHORT ROTATION INTENSIVE CULTURE

Among the species fit for energy plantations using Short Rotation Intensive Culture (SRIC) we can mention poplar and black locust, which range all over the Country, and the eucalypt in Middle and Southern Italy.

As for the eucalypt, in spite of the persistent attempts carried out during the last decades, particularly in Sicily and in Calabria, there have been many difficulties in spreading this species even for ecological reasons, and one cannot forsee possibilities for its development in the future. The black locust and, to a lower degree, the alder, are species of some interest but they are still at the experimental stage.

The poplar offers greater possibilites, especially the euro-american hybrids which, even if cultivated in limited areas (less than 1.5% of the Italian forest area), supply more than 40% of home produced wood for industry. Poplar growing in Italy is carried out for purposes which are far from the production of wood as an energy source.

In order to understand this choice, it is necessary to examine in detail the characteristics of the Italian cultivation pattern, of the wood market and of the prevailing uses of poplar wood in our Country.

Poplar culture

Poplar culture is carried out in Italy mostly in fertile alluvial soils of the Po Valley situated in typical flooded soils or in agricultural areas with a good water supply from the water-table or from irrigation. It is conducted according to strict agricultural standards and is characterized by high inputs of energy and money (fertilizing, irrigation, pruning, pest and disease control), with short rotations (10-12 years) and average spacing (300 trees/ha), but it achieves high production (an average of 20 m^3/ha/year) of good quality wood which is for the major part destined to the plywood industry.

The poplar wood market in Italy is characterized by a certain instability, due to the unbalance between demand and supply which takes place periodically, with consequences on planting and felling. The poplar plantation area, which in 1980 was around 134,000 ha, subsequently decreased to about 107,000 ha in 1987, with a reduction of 20%. Felling increased continuously from 6,000 ha a year in 1980 to about 15,000 ha in 1987, with an increase parallel to the amount of removed wood (from 1.3 to 3 million cubic meters). On the other hand, the establishment of poplar plantations has decreased at an average of a about 6,000 ha per year with a minimum of 3-4,000 ha per year during the last 2-3 years.

The increase in supply coincided with a drop in prices which varied from 100,000 It. lire/m^3 in 1980 to 57,480 It. lire/m^3 in 1985 for standing trees on the market of Pavia (Borelli, 1989).

According to estimates made by the Poplar Research Institute, from the 90s a reduction in the supply will be noted which will progressively drop until the beginning of the year 2000 when it will presumably reach values lower than 1 million cubic meters. There is no doubt that the supply reduction will correspond to a price increase so that during the next few years the poplar will once again offer extremely favourable prospects on the market.

In order to evaluate the importance of poplar wood and its chief uses in Italy the following few figures should be taken into consideration. Of more than

24 million cubic meters of roundwood used by industries, about 5.6 million cubic meters is poplar wood (including that imported) out of which 19% is used by the plywood industry, 11% by the pulp and paper industry, 25% by the chip- and fiber-board industry, 36% by the packing-crates industry and 9% by the sawn timber industry. A very significant figure, in order to understand the importance of poplar wood in the different sectors of transformation, is the ratio between the quantity of this raw material consumed and the total of tree species employed. This ratio is decidedly small in the saw mill sector (0.04), relevant in the paper industry (0.31), the packing-crates industry (0.40) and of the chip- and fibre-board industry (0.55) and very high in the veneer and plywood industry (0.73) (Borelli, 1989).

These figures prove that poplar wood plays a fundamental role especially in the manufacture of plywood. This sector of transformation, unlike all the other sectors, has a productive activity strictly connected to the utilization of poplar trunks preferably in a fresh stage, of great size and endowed with particular technological characteristics such as the absence of inner defects (e.g. knots, tension wood) or defects caused by biotic agents (e.g. wood boring insects) or abiotic agents (e.g. frost).

The price of poplar clearly decreases as we pass from the material for veneer (which must have a minimum diameter of 20 cm) to the one for sawing (minimum diameter 16-20 cm), the one for the paper industry (minimum diameter 8-10 cm), the one for chip- and fiber-boards (minimum diameter 3-4 cm). At present the prices of the various assortments are 13,000, 8,000, 5,500, 3,500 Italian lire respectively, with a ratio of 3.85:2.45:1.65:1.0.

The price of standing poplars is practically determined on the basis of the percentage of plywood that can be obtained from it and, as a consequence, the production is directed to maximize this assortment; a demonstration of this is the duration of the rotations (10-11 years) and the spacing (280-300 trees per hectare) most commonly used. This cultivation pattern, which has been adopted by poplar growers with the development of the plywood industry since the

20s, is practically unchanged, although the differentiation of the assortments of average quality decreased as a consequence of the drastic fall on the market in boles for sawing towards the end of the 60s and in pulp-wood towards the end of the 70s (Borelli, 1989).

The assortment for veneer has a function of stimulating the demand of poplar wood and may be defined as the actual "product", while the assortments for less valuable utilization can be considered as "by-products".

Since the weighted mean price of the assortments of poplar wood is the reference point for evaluating the convenience of poplar culture, it is probable that in Italy, at least in the near future, the wood destined for trituration or as an energy source will continue to represent a complementary product of our poplar plantations as compared to the more valuable assortments.

Experimentation in progress on poplar and willow SRIC

A poplar cultivation pattern solely for the production of material for chipping is not economically convenient under the present conditions in Italy (Prevosto, 1984).

Nevertheless, the increasing demand of wood material for the paper industry and for the chip-board industry and especially the possibility of utilizing the biomass for energy use justify the interest of the experimentation aiming at the valuation of the productive potentialities of the Salicaceae in dense plantations with very short rotations. In the present economic situation, this line is hampered on the one hand and favoured on the other hand. The obstacles consist in the difficulty of commercializing (in connection with the inadequacy of the market), in the lack of a specific mechanization of harvesting and also, for energy purposes, in the relatively low cost of fossil fuel. The favourable elements consist in the possibility of establishing the SRIC in soils set aside in order to reduce agricultural crops exceeding European needs. These set-aside soils receive a contribution which alternative chosen cultures, including poplars, can profit by. But this is probably not enough to adequately check production costs.

A very important item in the economic balance is represented by establishment costs. Hence the SRIC must be exclusively thought of as plantations to be established on marginal or unused agricultural land using cuttings or 1-year old saplings and to be subsequently managed as a coppice using the most economical growing techniques.

The Italian experimentation, which has been in progress for more than one decade, has already given interesting results with regard to biological and cultural aspects. This allowed the drawing up of an economic balance which showed that the expenses are higher than the income.

Poplar and willow clones, with excellent productiveness, have already been detected (Frison et al., 1979; Mughini et al., 1984, Sekawin et al., 1985). Spacing tests have demonstrated that as density increases, the total production increases too, but the diameter of the single tree decreases with a consequent increase in costs per unit of mass produced. On good sites, with spacings of 3x2.50 m and rotations of 5-6 years, trees of varying sizes are obtained within fairly large limits: diameter at 1.30 m from the ground from 10 to 20 cm, total height from 15 to 20 m and total fresh weight (stem+top+branches) from 100 to 200 kg each tree. The mass produced varies according to the clone, from 20 to 60 t/ha/year (Frison, 1980 and data to be published; May, 1982).

Coppicing tests have proved that the production of the second rotation is higher than the production of the first one. For poplar coppices special volume and weight tables with double entrances (diameter at 1.30 m and total height) have been made so as to determine the production of wood biomass (Frison, 1979).

Briefly, the results confirm that for the production of biomass with poplar and willow, dense plantations and mini-rotations are adequate. From the practical point of view, it is very important to choose spacings which will allow the use of machines for maintenance and harvesting.

Apart from economical conjectures, it is necessary to further deepen the knowledge of the biological and cultural aspects (seeking other poplar and

willow clones having high production capacities, particularly suitable for narrow spacings, with excellent sprouting capacity and long-survival stumps, and with good resistance to parasites) and to carry out a whole series of surveys on the physical aspects (production, energy values, quantitative ratios between wood and bark, mechanical characteristics of the material).

Under Italian ecological conditions, resistance to parasites is of great importance. The parasites are in fact particularly aggressive in microclimatic conditions typical of coppice stands where trees are physiologically weaker due to high density.

All this is being studied in current tests. Furthermore, a new research project involving the appliance of biotechnologies and the study of some physiological factors in SRIC of poplar and willows have been presented to the EEC by the Poplar Research Institute in collaboration with several other European Countries (JOULE Project).

The future line of research will depend on the results of the analysis of the abovementioned factors and the possibility of extending the SRIC on a larger scale will be determined by the interest biomass will arouse and by the related market conditions.

CONCLUSIONS

As in other industrialized countries, in Italy in the recent past renewable energy sources, especially fuel-wood, were prevailing. The development and the civil progress of modern economies have been possible thanks to the abandonment of these resources to the advantage of more centralized, more efficient and more reliable energy systems. Having only poor supplies of fossil fuels, Italy was, and still is, dependent on foreign countries for 83% of the total energy consumed and this fact makes it particularly vulnerable in case of a worldwide crisis of supply. Italy is therefore strongly interested in diversifying its own energy sources and, consequently, in the experimentation of

renewable sources, including biomass. The development and use of these sources, as compared to the conventional ones, presently much more used, are now hindered by their characteristics (difficulty of accumulation, discontinuity and intermittence of production) and by high production costs.

Nevertheless, the renewable sources, and especially biomass, cannot be considered as alternative resources to fossil ones and may only have a complementary role in the future, particularly in favourable local situations, on a limited scale and in specific sectors.

At present the possibilities for biomass in Italy are scarce as far as the utilization of coppice is concerned and the perspectives for SRICs are not encouraging.

Though poplar culture is now aiming at the production of valuable assortments, at present there are many problems. If the present pattern were to be replaced or supported by the production pattern of energy wood, many other problems could arise.

In the future this situation could become more favourable as, on the one hand, SRIC would greatly increase biomass production and be extended to lands set aside, receiving contributions; on the other hand, the price of fossil fuel could increase. In anticipation of this possibilty, we are carrying on research work even though we are conscious that biomass in Italy, in spite of the precarious energy situation in our Country, will only play a complementary role.

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