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APPLICATION OF THE FORESTRY RESOURCES ANALYSIS AND PLANNING (FRAP) MODEL : AN ASSESSMENT AND PROJECTION OF FUELWOOD SUPPLY AND DEMAND IN MOROCCO AND AN INVESTIGATION OF POSSIBLE INTERVENTIONS

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Rabat, Morocco

Sept. 20 - Oct. 10 1986

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I. TERMS OF REFERENCE

Table 1 shows the terms of reference for the mission, and Table 2 outlines the work schedule. The objective of the mission was to help establish and train a core group of Moroccan specialists in forest energy planning techniques, using the Forestry Resources Analysis and Planning Model (FRAP). This mission training program was also to be used as a catalyst to improve the data used in the woodfuels modeling effort, and to begin the sensitivity analyses based on hypothesized investment projects. A third objective was to prepare a briefing on the use of the model for presentation to the interministerial commission on energy.

The core group of Moroccans that were introduced and trained in the use of FRAP were:

1). Mr. Mohammed Belghiti. Division de Developpement des Ressources Energetiques, Direction de l'Energie, Ministere de l'Energie et des Mines (MEM). Mr. Belrhiti was the obvious choice as the key individual to interest and train in the use of FRAP, having done considerable work in the area of biomass energy and fuelwood in particular. His Masters Degree from Hassan II University was titled " Bois de Chauffage et Charbon de Bois au Maroc", although he works with MEM he has a forestry degree, so that he can cross the interdisciplinary barriers within the various ministries. He is on the Interministerial Commission to Combat Deforestation. He was immediately interested in learning about FRAP, and although he had no previous microcomputer experience, he rapidly mastered the FRAP model.

2). Mr. M. Amanou (Chef de Service S.P.D.). Mr. Amanou knows computers and Lotus well and quickly understood the purpose and working of the FRAP model (which is written with Lotus macros). He continued to offer his help to Mr. Belghiti during the introduction phase and has offered to assist him in learning Lotus after the advisors' departure. Mr. Amanou has also offered to assist Mr. Belrhiti to translate the model into French as time permits. This will be valuable in appreciating the internal workings of the model.

3). Mr. Mustapha Bennani (SPD). Mr. Bennani also is familiar with computers and works with the Energy Planning Model. He too understood the concept and workings of FRAP very rapidly and has made very useful suggestions on its application. He continued to offer his support to Mr. Belghiti during the training phase, and has offered to translate the FRAP flowchart into French for ease of reference. Thanks to Mr. Bennani's familiarity with the project computer hardware and software, he was able to save two day's work when, at one point, a large quantity of data which had been entered into the computer was thought to have been lost.

4). Mr. Abdel-Aziz Nadhil (SPD). Mr. Nadhil is the Team member most familiar with "Analyse du Projet" module of the Energy Planning Model being developed by MEM and is therefore familiar with computers and Lotus. He too was able to understand the use of FRAP quickly. After learning about FRAP , he designed and printed out the Logical Diagram of FRAP (Figure 1).

II. WHAT IS FRAP?

2.1 Overall Description of the Model.

The Forest Resources Analysis and Planning Model (FRAP) is a detailed simulation model which projects forest resource supply and demand over a twenty-year period for up to twenty separate regions in a country. FRAP was created to replace simplistic projection models being used in several countries because such models were found to be unreliable indicators of the likely impact of major policy initiatives. FRAP strives towards three objectives: i) a high degree of technical accuracy; ii) maximum flexibility for the policy maker to define the parameters of the analysis, and iii) "user-friendliness", or ease of use. Not a single number is built into the model. Every number and assumption is defined by the user, and each can be varied for sensitivity analyses.

Twenty-two input tables (Table 3.) accept data by region on forest classification, average mean annual increments and stand volumes by forest zones, agricultural clearing, wood recovery, forest fires, herding, managed forests and plantations, and , on the demand side, rural and urban populations and growth rates, fuel mixes (urban and rural), energy devices and efficiencies, final energy demands by end-use (cooking, lighting, space heating, etc.), industrial and commercial wood energy consumption, non-energy consumption, non-energy wood demands and growth rates and demand elasticities, among others.

FRAP automatically links to a related model--INVEST-- which allows a user to create and cost a series of potential investments, including fuel substitution, supply measures (plantations, forest management, agroforestry, etc) and device efficiency improvements (kilns, stoves, etc.). Up to 180 different regional investment programs can be created on file and any combinations put together in alternative 'investment packages' which can be costed and then run to assess their impact. This link between INVEST and FRAP, which ties project cost, investment budgets and policy impact elements of natural resources decision-making, is perhaps the most innovative and useful feature of the model. A review of Figure 1 (a graphic diagram of the data input and expected output), and Figure 2 (a flowchart of the FRAP menus) will help to picture the concept of FRAP, and the interaction with INVEST.

2.2 Advantages of FRAP for National Planning.

FRAP was designed to project as technically accurate a base case as possible within the limitations of the data available on fuelwood production and consumption. The principal strength of FRAP is its ability, through sensitivity analysis, to systematically test alternative assumptions. The resulting projections capture the nuances of interrelationships and time patterns. These projections are useful to the planner to help identify major problem areas throughout the country and to assess the relative impact (and cost effectiveness) of hypothesized development strategies.

FRAP was developed by Energy / Development International in 1984. Since then the model has been applied in the Gambia, Mali, Sudan, and New Mexico for planning purposes. It has also been used as an interactive training tool in a regional energy workshop and at the Energy Management Training Program of the State University of New York at Stony Brook.

III. PROJECTIONS OF FUELWOOD SUPPLY AND DEMAND IN MOROCCO

3.1 The Regions.

Morocco is a highly diverse country in terms of topography and culture. This diversity results in extreme variations in localized fuelwood supply and demand patterns. One of the major advantages of FRAP is its ability to project the fuelwood supply and demand situation by regions, and also to assess the impact of investment options within the same regions. We have opted to use the same geographic divisions in the modeling effort as the 'Plan National de Lutte contre la Desertification' so that the analysis using FRAP will be consistent with the National Desertification Control Program. The division of the country into these 12 regions (see Table 4) was based upon homogeneity of vegetation, climate, topography, and sociological factors. The regional breakdowns are defined in detail in the final report of the 'Plan National de Lutte Contre la Desertification (Poupon, et al. 1986, Projet FAO TCP MOR 4506 (A).

To assure consistency, it is highly recommended that the AID/World Bank household energy survey also use this regional division of the country.

3.2 Sources of Data.

3.2.1 People Contacted.

During the team's previous trip to Morocco we conducted a full scale search for available secondary data on fuelwood yields and consumption in the country. As Mr. Belghiti has been working

on the fuelwood question for some time, he was able to confirm whether or not the data collected on the first trip was a complete set of that available. In fact several important papers had been prepared in the interim, to which Mr. Belrhiti had access. We were also able to make other key contacts to help confirm that the data now being input into the model are the best available. Those people contacted were:

- Mr. Aichouni, Eaux et Forets, Service Reboisement
- Mr. Ben Mbarek, Eaux et Forets, Div. du Domaine
- Mr. Samir, Eaux et Forets, Div. du Domaine.
- Mr. Mohamed Ziad, Eaux et Forets, Division de l'Economie.

3.2.2 Documents Consulted.

Appendix B lists the documents from which the secondary data was taken for use in the model. Many of these documents were left with the Energy and Natural Resources office at AID during the team's last visit. Any additional documents collected during this visit may be found at the ISTI office in Rabat. A number of reports in the documents room at Eaux et Forets also yielded useful information. However, they could not be photocopied, for lack of copying facilities at or near the Ministry.

3.3 Input Tables / Descriptions

Appendix A is a printout of the data base that was created on a Lotus spreadsheet for the purpose of dividing the data among the twelve regions. The creation of this data base will facilitate any future modifications in the data as new information becomes available and/or if a decision were made to change the regional breakdown used in the model. The sub-totals from this worksheet were entered into the appropriate input tables of FRAP.

3.3.1 Demand Side Input Tables

Table 5 is the input table that receives the rural population statistics by region. This table also accepts an estimated growth rate by region, which the program uses to project future population. In this case the national census estimation of 1.5 % growth for rural areas was used. Note that this rural population growth rate is considerably lower than the urban population growth rate (4.5%) due to migration to the cities. The average household size is also input into this table. We have used an average household size of 6 based on the best available information. Table 6 receives inputs specifying the urban population by region. In all FRAP input there is allowance for up to 20 regions, only twelve of which are being used in this application.

Tables 7-10 were designed to input data that is used to calculate and project household firewood and charcoal use by region and by degree of urbanization. Estimates of the efficiency of stoves and other fuelwood burning devices common in Morocco are input into Table 7. The estimates used here are in fact based on international studies because of the lack of appropriate information for Morocco. An efficiency of 10% means that 90 % of the potential energy of the wood is lost as waste heat as it is not directed upon the cooking surface. In Morocco, the most common cooking device in rural areas is a circle of three stones upon which a pot is placed. This is very inefficient since most of the energy is lost out the sides, between the rocks.

Tables 8 and 9 receive estimates on percentages of rural and urban households that use either firewood or charcoal for cooking. No solid information is yet available on these percentages for Morocco so these figures were estimated from an understanding of the regions and also work done in other countries. Note in Table 8, for the Saharienne region, a figure of only 10% was assigned for families using fuelwood. This was based on the assumption that animal dung is being used most often for fuel.

The final table used to project household fuelwood consumption is the Unit Final Demand table (Table 10). Input into this table is the per capita useful energy needed per year for each of the indicated uses. "Useful energy" is the energy which would be used if the energy consuming device were 100 % efficient. In the case of cooking, this would be the amount of energy actually transferred to the cooking pot. The estimated per capita fuelwood use can be calculated backwards from these figures by dividing the final unit demand by the stove efficiency (e.g., an individual requiring 0.08 cubic meter of "useful" wood energy per year for cooking would have to burn .08 ÷ 10 percent = 0.8 cubic meter of wood for that purpose). There are very limited useful data on per capita wood energy used in Morocco. DANIDA performed a household energy study in the Cercle de Targuist in 1984, but the information cannot be extrapolated over the entire country. The figures for Targuist are probably well above average because this region is high in elevation and therefore a large amount of the fuelwood used is for heating. For the lack of Moroccan data, we used global ecological zone estimates developed by FAO (Montalembert and Clement, 1983): 0.8 M3 of fuelwood/person/year for rural residents. Note that a value of zero was assigned to the Presaharienne and Saharienne regions for wood demand for heating. As better data is collected on household energy use, larger values should probably be entered for the higher elevation regions such as Haut Atlas Central.

Tables 11 and 12 input estimations on firewood demand for industry and commerce (Table 11) and charcoal demand for industry and commerce (Table 12). These figures were calculated as a percentage of total household fuelwood useage for urban and rural

households. Some have estimated that 5 % of total estimated household fuelwood use is for artisanal purposes (Michaelides, 1983). For lack of better information, wood demand for industry was calculated using the formula ((urban population * demand for industry and commerce was calculated using the formula (urban pop x .1M3*.05*.25). In these equations it was assumed (hypothesized) that 100% of the rural residents used firewood for this purpose and that only 75 % of the urban residents (who used fuelwood at all) used fuelwood (and 25 % used charcoal). The database (filename zones. wkl) may be consulted if there are any questions regarding these formulas.

Table 13 allows for elasticity in fuelwood demand as this form of available biomass becomes more scarce. The value entered in this table represents the percent of wood supply shortage in a region that is met by decreasing consumption. This assumes that a wood supply shortage will force consumers to reduce their usage, and is an approximation of the economic concept of price elasticity of demand. An elasticity of 10 % is assumed for each region in the base case.

The non-energy demands are input into Table 14. These include wood used for construction, furniture, handicrafts, exports, paper, etc. A World Bank report (1985) estimates that this consumption averages 41.9M3 per 1000 capita (i.e., 28.3M3 for sawnwoods, 5.8 M3 for wood based panels, and 7.8 M3 for paper and paper board). Because of the lack of precise regional data, we assigned a value of .04 M3 per capita (rural and urban). It may be more accurate to assign a higher relative value for urban residents but this refinement can be added in later runs. The growth rate of this usage is based on the average growth rate of the total national population (Annuaire Statistique du Maroc, 1984).

3.3.2 Supply Side Input Tables.

Data on total area of foresty or vegetation type is input into Table 15, by region. For the Morocco case, the fuelwood producing types have been divided into cedar forests, oak forests, Thuya forest, Argania (and secondary species) forests, reforested areas, fruit orchards, and semi-arid to arid shrubland. The data for total area in each category came from the documents 'Conseil National des Forets' (MARA,1986), 'Pastoralisme et Lutte contre la Desertification' (Poupon,1986), 'Le Maroc Forestiere' (MARA, 1981), and 'Enquete Agricole--Principales Productions Vegetales' (MARA, 1984). Each type was assigned an annual fuelwood productivity level in cubic meters, and a present year stand volume estimate, also in cubic meters. The productivity estimates of the forest types comes from Zitan (Eaux et Forets, Div. du Domaine). The fuelwood productivity levels of the other categories are best guess estimates based on the authors'experience with biomass harvesting in other countries (but unfortunately in the absence of visual assessment). These figures are highly hypothetical and need to be confirmed with visual and harvesting measurements (a proposed future task).

The category 'Parcours hors Foret' was assigned a production level, albeit very low. This was to account for the use of shrubs as fuelwood. A Peace Corps Volunteer found in a non systematic study that a family could use 21 shrubs (sagebrush) a day to cook tea (Visness, 1985). It is very important to assess the potential biomass available as fuelwood on shrublands in order to improve estimates used in the model. The alfa (Stipa grass) steppe was also included as a vegetation type in Table 15 (although with a zero yield assignment for fuelwood) because of its importance in overall size and also because we understand that people use parts of this grass as fuel. We have chosen not to assign it a fuelwood productivity status so as not to confound the projections of wood biomass. Nevertheless this is an important vegetation type and if in fact a large population depends upon it for fuel, it should be included in the model in the future (once there is better information on its use). Animal dung--an important fuel source in some regions--might also be included on the supply side by estimating the number of hectares, a volume of dung per hectare, and the calorific value of dung. Such an estimate would be especially relevant for the Saharienne and Presaharienne regions.

Table 16 inputs the number of hectares of forest cleared for each new inhabitant each year. These values are based on an average number of hectares cleared in each region over five years (Conseil National des Forets, 1986), divided by the rural population of each region. We have assumed that 30 % of the stand volume that is cleared is used for energy, and the rest is wasted.

There is apparently very little information on grazing impacts on forest productivity. Until that information is available, we have chosen to assign a hypothetical value to this category (Table 17). The total hectarage entered for each region is the sum of all forest types by region (i.e., we have assumed that all forests are subject to some grazing damage). Tentatively we have assigned a very low impact (5%) on yield.

We were also unable to find useful information on "managed forests" in Morocco. Most of what are called managed forest are simply forests that have been 'studied' and protected. Additional information is needed on whether any forests are actually managed for improved yields (i.e., thinnings, etc.). Until we can clarify this point we have chosen not to assign a value to the Managed Forest Table (Table 18).

3.4 Results (Base Case).

Using the best available data, and under the constraints of the assumptions we have made, FRAP has generated, in graphic form, 20-year projections on both the national and regional levels. We will refer to this scenario as the 'Base Case', as it represents the projected future in the absence of any corrective

intervention. The ensuing discussion will not be in terms of precise amounts, but rather will address the more important question of relative differences in yield and consumption (i.e., deficit vs surplus) between cases.

3.4.1 National Projections.

Figure 3 projects the Base Case fuelwood supply and demand for Morocco as a nation. From the input data, FRAP estimates a sizable current deficit, consumption being over twice supply. It should be noted that a fuelwood "deficit" means simply that fuelwood resources are being consumed ("demand") faster than the forest can generate new wood ("supply"), and that therefore the overall average density of forest cover is decreasing. The current prognosis is that without any intervention, this already critical situation will continue to erode into year 2005. The widening gap between supply and demand with time (Figure 3) represents a decline in forest resources at an ever-increasing rate. Figure 4 displays an overview of the projected regional status in year 2005. As the deficit widens and the perennial vegetation declines, one can expect the ecology of the country to degrade (i.e., soil erosion, decreased rain-fall, decreased agricultural productivity, degraded rangelands, etc.).

How do these projections compare with the projections of others? Others have estimated that fuelwood consumption is approximately 9,000,000 to 11,000,000 M3 per year and the total supply is only 3,000,000 M3 per year (World Bank - 1985, Michaelides - 1983, E3I-1984). Speaking in absolute terms, our estimation for demand is closer to 14,000,000M3 per year and supply 6,000,000M3 per year. Why the difference? Unlike the other estimates for demand, FRAP has also taken into consideration the fuelwood and charcoal demand for industry and commerce as well as the non-energy demands of industry. While the other estimates are based on the forest resource alone (which is only 7% of the total surface area of Morocco) FRAP has also accounted for fuelwood supplied from other sources such as orchards, vinyards, and shrublands. We consider this last point very important in view of the fact that a relatively small percentage of the population lives near enough to the forested areas to utilize those resources. Most of Morocco is semi-arid to arid country, devoid of forests.

3.4.2 Regional Projectons.

Figures 5 through 16 give twenty-year "base-case" projections for each region seperately. These are useful for assessing the nuances of regional differences. The Moyen Atlas Central, a highly forested area of the country, is the only region in which there was an initial surplus; however, with time even this is expected to shift. The Chaouia (Figure 13) and of course the Saharienne (Figure 16) regions are very dry and produce little woody biomass. Figures 13 and 16 indicate the need to know more about the kinds of fuels being used by the average rural family.

For a complete understanding of regional differences, it is helpful to compare these regional graphs with the information on forest types and extent in Table 15.

IV. EFFECTS OF INVESTMENT PROGRAMS ON SUPPLY AND DEMAND BALANCES

4.1 Investment Options.

INVEST is an interactive program that was designed to work in tandem with FRAP in order to test investment scenarios under sensitivity analysis. With this program, 9 different investment programs may be created for each region by the user, a potential total of 180 investment programs for 20 designated regions. The following table summarizes briefly various investment options analyzed using the data in this report. These options are described below.

4.1.1 Investment Programs Affecting Supply

a) National Reforestation Plan (REF1)

The first intervention tested was based on the National Reforestation Plan, which calls for the reforestation of 22,000 ha. each year. Tables 19 and 20 are the inputs required for INVEST to create this investment package. The program begins in year 1 and continues new planting in each subsequent year. Based on information from Eaux et Forets, we have allowed for 7 years before first harvest, with an expected harvest yield of 4.5 M3/ha. Table 19 is used to assign a number of hectares to be planted to each region. We assigned these numbers based upon Mr. Belrhiti's understanding of the regions and the priorities for reforesting these regions.

The results of the Reforestation Case indicate that this reforestation activity will have little significant impact on the overall projected national deficit as seen by comparing Figure 17.a with Figure 3 (Base Case). This first run should not be interpreted to mean that reforestation is of little use. On the contrary, it is very important, especially for soil and ecological conservation purposes. The usefulness of this first run is to indicate that reforestation (at this level and under the assumed productivity) is not sufficient for meeting the fuelwood deficit, even if all 22,000 hectares were in fact established each year (which has been difficult to achieve in the past).

b) Modified Reforestation Plan (REF2)

The reforested areas of Morocco are not generally managed for fuelwood. If they were, the production time could be cut in half and the productivity could also be increased. Improvements that could be made to increase productivity and shorten production time include: using fast-growing species adapted to the climate,

Investment scenarios run on FRAP for Morocco, Oct. 1986.

NUMBER	CODE	SCENARIO
1	B	Base case (i.e., without intervention)
2	REF1	National Reforestation Plan (22,000 ha/yr) (1-20 yr)
3	REF2	Reforestation @ 22,000 ha/yr and use SRIC @ 4 yr to prod and 7 M3/ha. Project life: 1-20 yr.
4	REF3	Reforestation at 44,000 ha/yr (2 * NRP) and with SRIC as #3.
5	Rc1	Woodlots at 1/2 the ha/region as case #2.
6	FA1	Improved Cook Stove (Extend to entire rur.pop. yr 1-20)
7	SUB1	Stoves using conventional fuel (substitution all rural pop, yr 1-20.)
8	FS1	Imp stove (1/2 rur pop,yr 1 to 20) + substitution (1/2 rural pop, yr 8-20).
9	R1F1	Reforestation (# 2) plus improved stoves (#6)
10	R1RcF1	Cases # 2,5, and 6 combined
11	R1F1S1	Cases # 2, 6, and 7 combined.
12	RFCSM	Reforestation with improved wood and charcoal stoves, substitution, and improved kilns.

using closer spacing, cutting at shorter intervals with subsequent cuttings being from the coppice material. The term for this kind of management is Short Rotation Intensive Culture (SRIC). Technology for this kind of management is currently being developed under the U.S. Department of Energy's Short Rotation Woody Crops Program (SRWC).

We have run another scenario based on the National Reforestation Plan, but using SRIC technology for fuelwood production. In this scenario we have shortened the production time to 4 years (time of first cut after planting), and increased the productivity from 4.5 M3 to 7M3 (which we consider conservative, even in semi-arid Morocco). The number of hectares to be planted in each region remains the same. Under these improved conditions the national projections (Figure 18) indicate that the decline in yield (forests) is stopped. The level of fuelwood supply continues at about the same level throughout the 20 year projection, even as the population and consumption of fuelwood continue to climb. In the Moyen Atlas Central region, FRAP shows that this investment option is sufficient to influence an increase in supply such that the surplus status was maintained throughout the 20 years. This scenario, however, did nothing to improve the status of the Chaouia and Saharienne regions due to the fact that little reforestation is possible in these dry areas.

c) National Reforestation Plan Doubled and SRIC (REF 3)

The next scenario was to double the number of hectares planned to be planted under the National Reforestation Plan, and also use SRIC technology. These measures would significantly increase supply over the next 20 years (Figure 19). Under this investment option, both the Moyen Atlas Central and the Rif Oriental would have a surplus production of fuelwood through year 2005.

There are questions that need to be answered concerning the realism of the above reforestaton programs. In particular, is there enough available land for this level of reforestation, or will there be a major conflict with farmer needs. Another question is whether or not Eaux et Forets would be able to manage these higher levels of reforestation. Also these programs are very costly to implement. Although this third option (doubling the hectares to be planted under the National Reforestation Plan) seems to reverse the trends in the fuelwood supply situation, projected consumption trends continue to outpace supply. As consumption is obviously the larger component in these projections, it may prove easier (and less costly) to attempt to implement "demand" management programs that decrease consumption to the level of production rather than to increase supply to the level of consumption.

4.1.2 Investment Programs to Manage Demand

Two types of demand management investment options were considered:

a) improvement in the efficiency of woodstoves, and
b) substitution for woodfuels by other sources (butane, kerosene, biomass, renewables, etc.).

Several cases were run to test the impact of different rates of stove dissemination and levels of efficiency. Alternative start and end dates for dissemination programs were also tested, as was a combination of both improved stoves and woodfuel substitution. Three of the cases run are reported below. The "stoves" case described is for improved woodstoves (as opposed to charcoal stoves). For comparability, the "substitution" case is also based on woodstoves: that is, in this case, the number of wood-using households who switch to substitute fuels is exactly the same as the number who switched to improved woodstoves in the stoves case. Dissemination and fuel substitution cases concerning charcoal stoves are not explicitly treated below, but are being tested as part of the on-going analysis being performed by Mr. Belghiti.

a) Improved Woodstoves Case (FA 1)

The improved woodstove hypotheses are not tied to either massive stoves or portable commercialized woodstoves. That choice should be based on market acceptance and speed of dissemination. In the woodstoves case, dissemination begins in Year 1 and continues through Year 20. Conversion efficiency for the new stoves is put at 20%, which is double that assumed for the traditional three-stone stove. Finally, the case tested attempts to achieve full saturation of all households presently using wood for cooking in ten to fifteen years (it varies by region). This admittedly optimistic assumption is used to demonstrate the potential -- and limitations -- of stove related programs rather than to define a realistic policy objective.

Figure 20 shows the National and Regional results for this case. At first glance, the National graph shows little perceptible change from the National Base Case. However, a more careful review is warranted. Note that National Base Case demand reaches about 22.3 million M3 in 2005, while in the woodstoves case demand in that year is less than 18.5 million. The upward slope of the demand curve remains lower throughout the "stoves" case. Another interesting result can be seen in comparing the Year 20 supply numbers in the two graphs. While it is barely noticeable in the graphs, the FRAP tables confirm that the Year 20 supply in the "stoves" case is approximately 15% higher than in the Base Case, despite the fact that no tree planting takes place in this case. This "induced supply" effect occurs because lower demand reduces the rate of deforestation, allowing both stand volumes and yields (supply) to remain higher.

Overall, the effect of improved stoves is limited in the National case because urban charcoal use, and all non-cooking uses of wood (including heating, lighting, commerce and industry, and non-energy uses) are not taken into account, and because population growth continually offsets a portion of the gain.

The Presaharienne (Figure 20.e) woodstoves case is representative of the impact in predominantly rural regions where the majority of households use wood and are thereby affected by this investment option (see Figure 23 for an overview of urban versus rural population by region). Demand declines sharply (more than offsetting population growth) until full saturation is approached. FRAP automatically limits new stoves at this point to the level required to maintain full saturation. Total demand in Year 20, from more than 1.3 million m3 in the Base Case (Figure 15) declines to just over 0.9 million m3 in the woodstoves case. Forest yields decline at a slightly slower rate, and the supply-demand deficit is considerably reduced. The speed at which full saturation is achieved is partially because many rural dwellers use dung, rather than wood, as their primary fuel (we have estimated 35% of rural households in this category), and therefore the number of stoves improved each year (which this run ties to a fixed proportion of rural population in each region) saturates wood-using households more rapidly.

b) Substitution for Fuelwood Use (SUB 1)

Butane consumption in Morocco has seen a 14% annual growth rate in recent years. This is well in excess of the rate of urbanization (4.5%-5.5%). The difference is either attributable to greater per capita consumption among existing users or to substitution by butane for other fuels (including wood and charcoal). Recent World Bank Energy Assessments for a number of countries have found the financial cost of kerosene to be lower than the financial cost of wood in many urban areas, if conversion efficiencies are taken into account (i.e., the financial cost of "net useful energy" is lower). It is also widely recognized that in semi-arid areas the economic value of wood exceeds its financial cost (retail price) when wood is collected from the forest as a free good. Finally, there is increasing documentation of the fact that loss of tree cover has a negative long term impact on soil fertility, by increasing susceptibility to wind and water erosion, reducing the nutrient cycling function of roots, etc. Therefore, it is becoming increasingly relevant to evaluate the tradeoffs between negative agricultural and environmental impacts of deforestation, on the one hand, and the cost of substitute fuels on the other hand (especially imported fuels, use of which requires scarce foreign exchange).

The "substitution" case considered here has the same start-up year as the improved woodstoves case, and assumes the same annual rate of dissemination. Figure 21.a shows the National substitution graph, and Figure 21.d shows that for Gharb Mamoura, which is thought to be representative of regions with sufficient

infrastructure and proximity to distribution centers to allow development of a distribution system over time. For purposes of comparison to the woodstoves case, Figure 21.f shows the graph for the Presaharienne region.

The "substitution" case assumes that only households that use or are projected to use wood stoves switch to substitute fuels. Charcoal users are not considered. Once 100% saturation is achieved in a given region, further dissemination is limited to the number necessary to maintain saturation. The impacts in all three regions mentioned are significant relative to the Base Case. In the National graph, demand declines from 22.3 million m3 to 14.5 m3. In Gharb Mamoura, it goes from 3 million m3 to less than 2 million m3. In this same region, the "induced supply" effect is substantial. In the Presaharienne, demand follows the same pattern as in the "stoves" case (the same penetration rate is used), but the declines are much sharper, with a year 20 demand of 650,000 m3 versus 900,000 m3 for the "stoves" case and 1.3 million for the Base Case.

A number of complex relationships determine the rate at which demand declines, the level at which it resumes growth and the size of the proportional impact in each region. These include the relative sizes of urban and rural population, the number and share of wood using households in both urban and rural areas, and whether non-wood users use other woodfuels (such as charcoal), or non-woodfuels, such as dung, butane, etc. In varying degrees, the following are true for the National, Gharb Mamoura and Presaharienne regions in the "substitution" case:

- even when full saturation is achieved, the impact is not sufficient to bring and keep demand below annual supply

- eventually demand resumes its upward trend once all wood using families switch fuels

- the resumed upward slope is because cooking charcoal use, non-cooking wood and charcoal use (including industry/commerce, heating and lighting), and non-energy wood use (such as construction) continue to grow. The level of demand when full saturation is achieved is an indicator of the extent to which demand is due to factors other than wood used in cooking.

c) Combined "Stoves" and "Substitution" Case (FS 1)

The "combined" case is shown as an example of a preliminary step in moving from cases run primarily to demonstrate potential impact, towards formulation of coherent policies. For stoves, the number disseminated is estimated at only half that assumed in the woodstoves case. Stove dissemination begins in year 1, and continues throughout, as in the previous case. Stove efficiency is 20%, as before. Woodfuel substitution is also assumed at half its previous rate. Because it is plausible that it will take several years before widespread substitution really takes hold,

substitution begins in year 10. The total number of households affected is therefore lower than in either the "stoves" or the "substitution" case, and the timing of their introduction is different. The National and regional results (Figures 22) show major reductions relative to the Base Case and important improvements over the "stoves" case. Depending on the region, the impacts are not much less than for the 100 % substitution case, but for lower cost and with greater believability.

4.2 Relevance to National Fuelwood Policy and Planning

Literally thousands of alternative cases and combinations of cases can be run once the data base has been input into the FRAP tables. The process of improving national woodfuels and energy planning, however, requires an interactive process in which those cases which shed light on relevant and realistic policy objectives are systematically tested and compared. Two major tasks, each with related subtasks, stand out in this process:

- o database refinement
  - field observation and surveys
  - establishing and refining current year estimates
  - making base case projections

- o development of national policy and investment strategies
  - definition and costing of projects
  - impact assessment of projects and combinations of projects
  - comparison of cost versus impact of alternative strategies

The combination of the FRAP and INVEST models attempts to duplicate this process, and allows planners a tool to facilitate the very complex task of making technically accurate projections and sensitivity analyses. The quality of the results, however, depends on the success with which the overall effort -- of which the modeling effort is only a part -- takes place.

Very useful progress has been made during this mission in organizing and improving the base data available for woodfuels/forestry projections and analysis. Nevertheless, a number of key variables are still highly uncertain, and their accuracy should be improved.

On the supply side, field observation of several ecological zones is essential to determine the actual state of forest and other woody resources, and to refine estimates of annual yield and the current state of degradation. For selected zones, information should also be obtained either from field visits or from range programs on the potential impacts of animal grazing and forest fires.

On the demand side, household energy surveys are an essential means of establishing consumption patterns in relation to household income, fuel prices, social factors and access to alternative fuels. Because fuel substitution can have such a major impact on both woodfuel demand and supply and on overall energy consumption (and the balance of payments), much more information is required on the marketing and distribution system for woodfuels, for substitute fuels and for energy using devices (such as stoves). Ideally, such information would include prices, taxes, foreign exchange costs, cost structure, and analysis of user and distributor financial incentives. Not only will such information improve the quality of FRAP projections, but FRAP can be used to help determine information gathering prioritites. Through sensitivity runs, we can determine the variables which have the largest impact on outcome, and for which better accuracy should be given priority.

In the investment options analysis of this report, we have only performed a preliminary assessment of potential impacts for major "types" of measures. While the "supply side" cases accurately reflect plans established by the Comité pour la Lutte Contre la Désertification, the "demand" cases are purely hypothetical and only partially address the broad variety of cases which should be analyzed. The discussion below suggests a procedure for moving towards the next level of refinement in developing an "integrated" investment strategy on the demand side. It is to be stressed that the "Integrated Case" presented below is still far removed from what the realistic policies for Morocco might be, but is obtained through a process which will be duplicated at increasing levels of realism and project specificity from which a workable strategy emerges. One essential part of such a strategy will be the costing of specific projects in each region, and the comparison, not just of impacts on supply and demand, but of impacts per dirham invested. INVEST is set up to perform such comparisons, but we have not considered any detailed cost factors during this visit.

4.3 Moving from Scenarios to Strategies

Figure 24 shows the breakdown of population using wood (WOUSING) and charcoal(CHUSING) in urban and in rural areas, for Year 1, by region.

Figure 25 shows the distribution of total wood demand (in cubic meters) between wood use for cooking (WDCOOK), charcoal use for cooking (CHCOOK) and non-cooking and non-energy wood (WDOTHER) and charcoal (CHOTHER) use , by region, for Year 1. Figure 26 shows the same information for the Base Case projection in Year 20.

This information provides a starting point in calibrating an investment strategy. Similar data are available for the supply side, but are not presented here because the Integrated Case treats only the demand side. We note the highly uneven distribution of wood and charcoal use by region, depending

largely on the degree of urbanization, as can be confirmed by comparison with Figure 23 which shows urban and rural populations by region. Clearly, an appropriate strategy should be articulated on a region-by-region basis, rather than for the country as a whole. Moyen Sebou, Gharb Mamoura, Haouz-Tadla, Chaouia and Secteur Atlantique stand out as the largest charcoal consuming regions in Morocco.

In comparing the graphs for population and fuel types, it can also be seen that the proportion of people using charcoal is lower than the relative share of wood consumption attributable to charcoal use. This is because in the process of converting wood to charcoal, between 80% and 90% of the calorific value of the wood is lost (we have used a conversion efficiency of 16% -- i.e. an energy loss of 84%). While charcoal stoves are generally more efficient than the traditional three stone stove, this increased efficiency is more than offset by the effect of the charcoal conversion loss. Even if charcoal stoves are twice as efficient as three stone stoves, each charcoal-using household consumes over three times as much equivalent wood as a wood-using household(assuming the same total energy demand).

Comparing the Fuel Type graphs for Years 1 and 20 (Figures 25 and 26), we see that the share of charcoal in total consumption increases over time, due largely to rapid urbanization. We have used a rural population growth rate of 1.5% and an urban growth rate of 4.5% (taken from census estimates). For most urban areas, we have assumed that ten percent of the population uses charcoal (the remainder being largely non-woodfuels), while the rural charcoal percent is generally half that or less (see input tables). Income is an important determinant of whether urban families use petroleum fuels, charcoal fuels or wood. Other important factors include accessibility and price. Only through household energy surveys and analyses of the marketing and disribution networks will it be possible to determine if the percent of charcoal users in cities will decrease, remain constant or grow over time. The impact of a change in assumption here would be significant, and would therefore affect future investment strategies as well.

It is obvious from the two Fuel Type graphs why the improved woodstoves case described earlier did not have more of an impact. Even if all wood consumption were eliminated, there would remain a sizable percent of charcoal consumption, non-cooking wood consumption and non-energy wood consumption. In the data input into FRAP, the majority of the WDOTHER category comes from non-cooking energy uses, such as heating and lighting, as well as industrial and commercial use of wood. Here again, surveys of both household energy consumption and of industrial/commercial users would vastly improve what are at present only rough guesses for these categories.

The "Integrated Case" (RFCSM), which is the final case performed for this report, makes the following assumptions:

o the number of wood and charcoal stoves disseminated in each region is a function of the number of wood and charcoal using households (calculated for each year by FRAP). The rates of penetration are lower than assumed in the woodstoves case.

o the substitution program now displaces both wood and charcoal stoves. The number of each type of stove displaced is assumed to be half the number of improved stoves of each type being disseminated. When saturation is approached and the sum of the improved and substitution stoves exceeds the number of remaining traditional stove users, FRAP gives precedence to substitution. Furthermore, saturation is maintained thereafter through substitution rather than through the spread of improved stoves.

o a charcoal kiln improvement program is projected to achieve saturation over twenty years.

The new efficiencies for each of these programs are compared to Base Case efficiencies below:

Investment Program	Base Efficiency	New Efficiency
Improved WdStoves	10%	20%
Improved ChStoves	20%	35%
Improved ChKilns	16%	35%

The results of the Integrated Case are shown in Figures 27.a through 27.e. It is useful to consider these results not just in the light of the overall improvement relative to the National graph, but also in terms of the regional impacts compared to those shown for the "stoves" and "substitution" cases discussed earlier. Based on the discussion of the results of earlier demand cases, the reader should be able to analyse this case and detect the principal reasons for differences in the intensity, timing and distribution of impacts. It may also be useful to evaluate the Regional graphs in light of the information shown in the Fuel Type graphs for Years 1 and 20.

4.4 Conclusions

4.4.1 Conclusions Relative to the Woodfuels Projections

With the exception of Moyen Atlas Central, woodfuels shortages and forest degradation will become severe in every region if no corrective action is taken. Better estimates of the input variables over time may change the immediacy of this conclusion, but will not render it invalid.

The negative impacts are not limited to the driest regions of the country. Rif Oriental and Gharb Mamoura provide good examples of regions in which the supply-demand deficit can easily deteriorate substantially from a better-than-average present situation.

Reforestation programs will have a limited impact at the National level, but the impact in specific regions can be substantial (for example in Rif Oriental and Moyen Atlas Central). However, the value of reforestation should not be confused with its impact on supply-demand balances. In appropriate form it can play a major role in the critical tasks of soil protection and environmental stabilization.

Demand management programs can cause significant reductions in demand and in the supply-demand deficit. Improved stoves programs (wood and charcoal), fuel substitution and kiln improvement all have an important future role to play. Demand management is the most cost effective way of reducing the deficit. Each improved woodstove put into regular use produces an annual wood savings approximately equal to the annual yield from a hectare of forest plantation.

Charcoal use results in much greater wood consumption than equivalent end-use of wood, because such a high proportion of calorific value of wood is lost in conversion to charcoal. Improved kiln and charcoal stove efficiencies therefore would provide substantial benefits.

Successful demand management measures will, in many instances, have a sizable "induced supply" effect. In many of the regions, the "induced supply" from an improved stoves program was greater than the impact on supply from reforestation programs.

Non-cooking and non-energy demand for wood comprises an important percentage of total consumption. It may be higher than 50% of the total annual yield from existing forests in certain regions. This demand should not be overlooked.

A successful national woodfuels strategy is likely to require a mix of interventions. Each intervention may have a different time pattern. Forestry projects will take 6 to 7 years to reach production while stoves programs can begin sooner. In certain regions, woodfuel substitution on a large scale is already taking place, while in other regions it will require a much longer lead time.

4.4.2 Conclusions Relative to the Work Agenda

A reasonable first estimation of the input data is now in place, and organized (via the FRAP input tables) in a fashion which will be useful for further policy analysis. This database should be shared with other relevant ministries to confirm or improve its contents.

Field visits to confirm supply side information are a high priority, as are the results of household energy surveys.

Several Ministry staff members have expressed the desire to see FRAP linked to the Energy Planning Model now being developed by MEM. The best way of doing this without losing the best features of FRAP is to develop a linkage module. Such a linkage would greatly improve the accuracy of the overall energy model with respect to woodfuels use, and therefore also with respect to the possible increases in petroleum which might result from substitution. It would also allow FRAP results to be measured in terms of balance of payments, institutional and other impacts measured by the Energy Planning Model.

It would be desirable to tie the results of the household energy surveys to be performed by AID and the World Bank to FRAP. The results of the surveys will, of course, affect FRAP inputs, but a computerized link to the database in which survey results are entered would permit much greater sensitivity and policy analysis than would otherwise be possible. This would also allow users to get much more useful information and insights from the valuable data which should be generated by household surveys.

V. RECOMMENDED FOLLOW-UP

5.1 Study Tasks for MEM Counterpart.

The following is a list of tasks that we have suggested Mr. Belghiti may be interested to undertake in order to further his understanding of the use of FRAP for national planning and also to improve upon the level of data that is available for the modeling exercise:

a). Learn to use the Lotus 123 software, which is the program used to write FRAP. Mr. Amanou, Chef de Service SPD, has offered to help Mr. Belghiti with this.

b). Try to confirm whether or not any of the national forests are in fact managed for increased production, and if so get regional information on number of hectares and estimated increases in yield under improved management.

c). Attempt to assess the extent to which alfa grass is used as household fuel in certain Regions. Also assess the percent of available alfa that is not presently being harvested for other uses (i.e., that is potentially available for fuel).

d). Gain a better understanding of what the people in the Saharienne Region use for fuel.

e). Collect any further information on improved stoves so that it may be entered into the model.

f). Continue to run different investment scenarios using both supply and demand side interventions. Try first programs spread over 20 years then try shorter programs with a quicker impact and compare the difference. For example:

i) First try to reforest 500,000 hectares over 20 years, then try the same program over 6 years and compare the results. What can be concluded?

ii) Try to introduce 1,000,000 improved stoves over 20 years and then try to introduce them over 6 years and compare the difference. What can be concluded?

iii) Try a combination of the above.

5.2 Other Recommendations

a). We recommend that Mr. Belghiti make a visit to the Energy Initiatives for Africa (EIA) program in Kenya to learn about the work being done on improved cook stoves. As the EIA program is an AID sponsored program, possibly the AID/Rabat mission could sponsor Mr. Belghiti's travel for this opportunity to appreciate how a similar program might be applied in Morocco.

b). The SPD personnel (Mr. Amanou, Mr. Bennani and Mr. Nadhil) have offered to help Mr. Belghiti translate the FRAP model into French. It is highly recommended that this be done in order to permit better access to the model by other potential users.

c). Fuelwood issues are of such critical importance to Morocco that a specialist (either foreign or Moroccan) should be assigned full-time to publicize and pursue them.

d) USAID should very seriously consider providing the MEM/DDRE with an IBM - compatible computer to continue work on the FRAP model and related issues and data.

5.3 Recommended/Required Followed-Up for the Project Team.

To date all biomass and ecological assumptions have been made for this modeling exercise based on the literature and conversations with people--not first-hand field experience. These hypotheses need to be developed and confirmed with field experience. Specifically the following is required:

1. Determine whether or not shrublands contribute to fuelwood resources and make a rough estimate of possible contribution (done through "grab sampling" and density measurements).
2. Observe and document people collecting fuelwood from sources other than the forests (eg., orchards, vineyards, etc.), and try to estimate the amount.
3. Determine if fallow land is a source of fuelwood and if so, to what degree and for how long.
4. Determine whether large-scale reforestation activities are possible or, as we hypothesize, not possible due to the conflict with the needs of the farmer.
5. Identify traditionally used agroforestry activities in the country and identify ways that agroforestry systems may be combined with traditional farming systems.
6. Assess types of household fuels used in the Saharienne Region and their sources and distribution channels.
7. Assess extent to which stipa(alfa) grass is used as domestic fuel.

The authors could return periodically to Morocco to begin addressing these issues, but they would by no means eliminate the important need for a full-time advisor noted in 5.2 (c) above.

We also feel that our activities with FRAP are highly complementary to the AID/World Bank Household Energy Survey, and should be coordinated as early as possible. Our current recommendations:

1. The Household Energy Survey should use the regional divisions set forth by the Plan National de Lutte Contre la Desertification. These are the 12 regions that we have used for the FRAP modeling of the fuelwood supply and demand in Morocco. Our activities will better complement each other if all are using the same geographic divisions.
2. Pay special attention to the use of non-traditional biomass for domestic fuel-in particular shrubs and alfa grass. Get samples for calorific tests.

T A B L E S

TABLE 1 - TERMS OF REFERENCE FOR THE MISSION

The Programme de Mission (TABLE 2) provides most of the details of the terms of reference for this mission. There are a few elements, however, which should be emphasized :

a) the primary objective of this visit is to leave behind a select group of Moroccans who understand and can use the FRAP model, and if possible, to leave them with several important and achievable tasks.

b) the second objective of this visit is to inform (through a presentation) the appropriate Government representatives of the important issues surrounding fuelwood use. A separate presentation will be made to USAID.

c) a follow-up visit will be scheduled to ensure continuity of attention to fuelwood issues.

As usual, Dr. Kirmse and Shaikh will jointly prepare a draft trip report prior to departure from Morocco.

TABLE 2

PROGRAMME DE MISSION
MISSION SUR L'ENERGIE FORESTIERE : R. KIRMSE ET A. SHAIKH
USAID / MEM

Vendredi	19 Sept		Arrivee de R. Kirmse
Samedi	20 Sept		Preparation/
Dimanche	21 Sept		Conge
Lundi	22 Sept		Rendez-vous avec USAID/MEM - Finalisation du Plan de Travail Presentation de FRAP aux experts marocains
Mardi	23 Sept		Revue detaille du modele et de la methodologie avec experts marocains
Mercredi	24 Sept		Visites aux Ministeres et d'autres sources des informations obtenus
Jeudi	25 Sept		en janvier, 1986
Vendredi	26 Sept		Consolidation des donnees de base - Visites supplementaires si recquis
Samedi	27 Sept		Previsions preliminaires _ Nationale et regionales
Dimanche	28 Sept		Conge
Lundi	29 Sept		Analyse des previsions preliminaires
Mardi	30 Sept	R	Discussions preliminaires des options d'investissement
Mecredi	1 Oct		Receuil des informations sur programmes d'investissements
Jeudi	2 Oct	R	Receuil des informations sur programmes d'investissements (Suite)
Vendredi	3 Oct		Arrivee de A. Shaikh Presentation aux experts marocains du modele d'investissement Analyse de sensibilite sur les options d'investissements
Samedi	4 Oct	R	Analyse de sensibilite sur les options d'investissements (Suite)
Dimanche	5 Oct	(R)	Conge
Lundi	6 Oct		Developpement et testing des Strategies d'Investissements
Mardi	7 Oct	R	Developpement et testing des Strategies d'Investissements (Suite)
Mecredi	8 Oct		Finalisation de Presentation Finale a l'USAID/MEM Discussions et analyses (groupe de travail) des resultats
Jeudi	9 Oct		Matin: Presentation informelle des resultats Apres-Midi: Presentation Finale Rapport ecrit preliminaire: MEM - E/DI
Vendredi	10 Oct		Depart de R. Kirmse et A. Shaikh
Vendredi	31 Oct	R	Rapport Final soumis a USAID/Rabat

R = Une partie de la journee consacree a la redaction du rapport preliminaire

TABLE 3

Inputs Accepted by the FRAP Model

The Following Inputs Are Accepted for Each Region or Urban Area

Population
- Household size
- Rural Population
- Rural Growth Rate
- Urban Population
- Urban Growth Rate

Efficiencies
- Wood Stove
- Lighting (wood)
- Heating (Wood)
- Indust1 (Wood)
- Indust2(wood)
- Charc Kiln
- Heating(charc)
- Indust1(charc)
- Indust2(charc)
- Indust3(charc)
- Comm1(charc)
- Comm2(charc)

Per Captial Demands
- Cooking(wood)
- Cooking(charc)
- Lighting(wood)
- Heating(wood)
- Heating(charc)

Summed Demands
- Sector1(wood)
- Sector2(wood)
- Sector1(charc)
- Sector 2(charc)
- Sector3(charc)
- Sector4(charc)
- Sector5(charc)

Urban Fuel Pcts
- Wood
- Charcoal
- Non-wood

Non-Energy
- Total/Region
- Growth Rate

Forests
- Nine GEMS
- Classification Types
- by type:
  - Hectares
  - Stand Vol
  - Yield

Land Clearing
- Ha/Person/Year
- Percent Reuse

Grazing
- Hectares Grazed
- Pct Impact on Yields

Managed Forests
- Base Yr Ha
- Yield

Plantations
- Base Yr Ha
- Yield

Forest Fires
- Total Hectares Burned
- Pct Light Nurn
- Pct Medium Burn
- Pct Intense Burn

Impact of Forest Fires
- Pct of Normal Yields from
  - Light Burn
  - Medium Burn
  - Intense Burn

NOTE: INVEST inputs not included in above.

Table 4. Regions and their provinces used by the Model

NATURAL REGIONS	PROVENCES
1 RIF OCCIDENTAL	TANGER TETOUAN CHEFCHAOUEN
2 RIF ORIENTAL	AL HOCEIMA NADOR
3 ORIENTAL	FIGUIG OUJDA
4 MOYEN SEBOU	MEKNES FES TAZA TAUNATE
5 GHARB-MAMORA	KENITRA SIDI-KACEM KHMISSET WILAYA DE RABAT
6 MOYEN ATLAS CENTRAL	KHENIFRA IFRANE BOULEMANE
7 HAUT ATLAS CENTRAL	AZILAL BENI-MELLAL
8 HAOUZ-TADLA	KHOURIBGA KELAA DES SRAGHNA MARRAKECH
9 CHAOUIA	SETTAT BEN SLIMANE w/ CASABLANCA MOHAMMADIA
10 SECTEUR ATLANTIQUE	EL JADIDA SAFI ESSAOUIRA AGADIR TIZNIT
11 PRESAHARIENNE	ERRACHIDIA OUARZAZATE TATA GUELMIN TANTAN
12 SAHARIENNE	ESSEMARA LAYOUNE BOUJDOUR QUEB EDDAHAB

TABLE 5 - INPUT TABLE
FOR STATISTICS
ON :

R U R A L P O P U L A T I O N Household Size > 6

Enter Base Year Population 1986			Growth Rate in Percent per annum		
	Population	Grth Rate		Population	Grth Rate
Rif Occident	746,005	2	Presaharienn	1,029,641	2
Rif Oriental	73,001	2	Saharienne	27,912	2
Oriental	366,750				
Moyen Sebou	1,518,062				
Gharb-Mamour	1,234,671				
Moyen Atlas	407,539				
Haut Atlas C	767,662				
Haouz-Tadla	1,485,625				
Chaouia	861,800				
Secteur Atla	2,005,966				

TABLE 6 - INPUT TABLE FOR STATISTICS ON :

URBAN POPULATION					
Enter Base Year Population 1986			Annual Growth Rate in Percent per annum		
	Population	Grth Rate		Population	Grth Rate
Rif Occident	703,451	4.5	Presaharienn	201,124	4.5
Rif Oriental	174,552	4.5	Saharienne	135,956	4.5
Oriental	515,371	4.5			
Moyen Sebou	1,063,727	4.5			
Gharb-Mamour	1,421,260	4.5			
Moyen Atlas	187,902	4.5			
Haut Atlas C	288,156	4.5			
Haouz-Tadla	795,667	4.5			
Chaouia	2,441,687	4.5			
Secteur Atla	750,567	4.5			

TABLE 7 - INPUT TABLE FOR EFFICIENCIES OF STOVES AND OTHER COOKING DEVICES

Press RETURN to Continue ... :::::::::::::::::::::::: [RETURN]

D E V I C E E F F I C I E N C I E S

Enter Base Year Efficiencies in Percent

Wood Stove	10		
		Charcoal Industry	30
		Charcoal Restaurant	25
Wood Bakery	25	Charcoal Other	25
Wood Brick Kiln	30		
Charcoal Kiln	16		
Charcoal Stove	20		

TABLE 8 - INPUT TABLE FOR PERCENTAGE OF RURAL HOUSEHOLDS USING FUELWOOD FOR COOKING

R U R A L F U E L P E R C E N T A G E S

Enter Percentage of RURAL Population Using Charcoal and Wood

	WOOD PCT	CHARC PCT		WOOD PCT	CHARC PCT
Rif Occident	85	5	Presaharienn	60	5
Rif Oriental	90	5	Saharienne	10	2
Oriental	85				
Moyen Sebou	85				
Gharb-Mamour	80				
Moyen Atlas	85				
Haut Atlas C	85				
Haouz-Tadla	70				
Chaouia	70				
Secteur Atla	70				

TABLE 9 - INPUT TABLE FOR PERCENTAGE OF URBAN HOUSEHOLDS USING FUELWOOD FOR COOKING

URBAN FUEL PERCENTAGES

Enter Percentage of URBAN Population Using Charcoal or Wood

	WOOD PCT	CHARC PCT		WOOD PCT	CHARC PCT
Rif Occident	5	10	Presaharienn	5	10
Rif Oriental	5	10	Saharienne	5	10
Oriental	5	10			
Moyen Sebou	5	10			
Gharb-Mamour	5	10			
Moyen Atlas	5	10			
Haut Atlas C	5	10			
Haouz-Tadla	5	10			
Chaouia	5	10			
Secteur Atla	5	10			

TABLE 10 - INPUT TABLE FOR PER CAPITA DEMAND FOR "USEFUL" WOOD ENERGY

UNIT FINAL DEMANDS

Enter Annual Per Capita Final Demand in Cubic Meters

	Cooking Wood	Cooking Charcoal	Lighting Wood	Heating Wood	Heating Charcoal
Rif Occident	0.08	0.07	0.00	0.03	0.00
Rif Oriental	0.08	0.07	0.00	0.03	0.00
Oriental	0.08	0.07	0.00	0.03	0.00
Moyen Sebou	0.08	0.07	0.00	0.03	0.00
Gharb-Mamour	0.08	0.07	0.00	0.03	0.00
Moyen Atlas	0.08	0.07	0.00	0.03	0.00
Haut Atlas C	0.08	0.07	0.00	0.03	0.00
Haouz-Tadla	0.08	0.07	0.00	0.03	0.00
Chaouia	0.08	0.07	0.00	0.03	0.00
Secteur Atla	0.08	0.07	0.00	0.03	0.00
Presaharienn	0.08	0.07	0.00	0.00	0.00
Saharienne	0.08	0.07	0.00	0.00	0.00

TABLE 11 - INPUT TABLE FOR FUELWOOD DEMAND BY COMMERCE /INDUSTRY

WOOD DEMAND FOR INDUSTRY AND COMMERCE

Enter TOTAL (not Per Capita) Demand fo Each Subsector (in M3)

	Bakery	Brick Kiln		Bakery	Brick Kiln
Rif Occident	18,104	18,104	Presaharienne	23,544	23,544
Rif Oriental	16,752	16,752	Saharienne	882	882
Oriental	9,218	9,218			
Moyen Sebou	36,150	36,150			
Gharb-Mamour	30,444	30,444			
Moyen Atlas	9,521	9,521			
Haut Atlas C	17,812	17,812			
Haouz-Tadla	34,918	34,918			
Chaouia	23,968	23,968			
Secteur Atla	46,541	46,541			

TABLE 12 - INPUT TABLE FOR CHARCOAL DEMAND BY COMMERCE / INDUSTRY

CHARCOAL DEMAND FOR INDUSTRY AND COMMERCE

Enter TOTAL (not Per Capita) Demand for Each Subsector (in M3)

	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5
Rif Occident	879	0	0	0	0
Rif Oriental	218	0	0	0	0
Oriental	644	0	0	0	0
Moyen Sebou	1,329	0	0	0	0
Gharb-Mamour	1,776	0	0	0	0
Moyen Atlas	234	0	0	0	0
Haut Atlas C	360	0	0	0	0
Haouz-Tadla	994	0	0	0	0
Chaouia	3,052	0	0	0	0
Secteur Atla	938	0	0	0	0
Presaharienn	251	0	0	0	0
Saharienne	170	0	0	0	0

TABLE 13 - INPUT TABLE TO SHOW ELASTICITY IN FUELWOOD DEMAND AS SUPPLY DECREASES

DEMAND ELASTICITY FACTORS

Enter Percent of Supply/Demand Deficit Met by Decreased Consumption

Rif Occident	10	Presaharienn	10
Rif Oriental	10	Saharienne	10
Oriental	10		
Moyen Sebou	10		
Gharb-Mamour	10		
Moyen Atlas	10		
Haut Atlas C	10		
Haouz-Tadla	10		
Chaouia	10		
Secteur Atla	10		

TABLE 14 - INPUT TABLE FOR WOOD DEMAND UNRELATED TO ENERGY CONSUMPTION

NON-ENERGY DEMANDS

Enter TOTAL (not Per Capita) Non-Energy Wood Demand in M3

	Demand	Grth Rate		Demand	Grth Rate
Rif Occident	57,978	3	Presaharienn	49,230	3
Rif Oriental	36,182	3	Saharienne	6,554	3
Oriental	34,284	3			
Moyen Sebou	103,271	3			
Gharb-Mamour	106,237	3			
Moyen Atlas	23,817	3			
Haut Atlas C	41,232	3			
Haouz-Tadla	91,251	3			
Chaouia	132,139	3			
Secteur Atla	110,261	3			

TABLE 15 - INPUT TABLE SHOWING ANNUAL PRODUCTION (YIELD) OF VARIOUS TYPES OF BIOMASS

	GENRE DE VEGETATION ET PRODUCTION				
	FORET CEDRE	FORET CHENE	FORET THUYA	ARGANIER/ ESS SECON	REBOISEMENT
Yieldm3/ha	1.69	1.40	0.50	0.30	4.50
StVolm3/ha	80.0	80.0	80.0	30.0	40.0
Rif Occident	3,952	73,261	2,385	285,827	44,666
Rif Oriental	11,501	13,752	100	82,821	36,848
Oriental	0	146,676	131,108	96,658	29,923
Moyen Sebou	44,854	296,364	90,206	147,418	45,230
Gharb-Mamour	0	235,213	51,173	113,469	144,157
Moyen Atlas	70,827	357,175	15,044	65,388	10,650
Haut Atlas C	906	339,305	27,658	96,410	6,229
Haouz-Tadla	0	193,993	37,924	219,804	18,440
Chaouia	0	25,737	12,425	26,822	23,349
Secteur Atla	0	71,067	203,582	854,046	53,706
Presaharienn	0	30,939	21,528	262,818	1,747
Saharienne	0	0	0	0	16
TOTALS	132,040	1,783,482	593,133	2,251,481	414,961

TABLE 15 (continued)

VERGERES VIGNOBLES	PARCOURS HORS FORETS	STEPPE ALFA	TERRE NON PROD BOIS	Total
0.30	0.02	0.00	0.00	::::::::::::
75.0	2.0	0.0	0.0	::::::::::::
21,500	471,326	0	254,083	1,157,000
14,400	0	68,800	739,778	968,000
24,600	5,438,666	1,638,000	163,369	7,669,000
179,300	451,965	156,018	1,588,645	3,000,000
62,300	256,378	0	975,810	1,838,500
9,500	1,239,441	668,600	565,875	3,002,500
43,400	514,385	0	684,207	1,712,500
119,700	1,222,246	0	1,095,393	2,907,500
16,700	88,998	0	1,218,469	1,412,500
83,900	1,754,867	0	1,873,832	4,895,000
43,700	16,755,962	50,015	143,791	17,310,500
0	0	0	25,211,984	25,212,000
619,000	28,194,234	2,581,433	34,515,236	71,085,000

TABLE 16 - INPUT TABLE SHOWING IMPACT OF CLEARING ACTIVITIES

L A N D C L E A R I N G

Enter Hectares Cleared Each Year Per New Inhabitant
Enter Percent of Stand Volume on Cleared Land Reused for Energy

	Ha/Year/Pers	Pct Reuse		Ha/Year/Pers	Pct Reuse
Rif Occident	0.05	30	Presaharienn	0.00	30
Rif Oriental	0.06	30	Saharienne	0.00	30
Oriental	0.01	30			
Moyen Sebou	0.01	30			
Gharb-Mamour	0.00	30			
Moyen Atlas	0.01	30			
Haut Atlas C	0.03	30			
Haouz-Tadla	0.00	30			
Chaouia	0.00	30			
Secteur Atla	0.00	30			

TABLE 17 - INPUT TABLE SHOWING IMPACTS OF GRAZING

G R A Z I N G I M P A C T S

Enter Total Ha. Subject to Grazing and Percent of Normal Yield

--	Total Ha	Pct of Yld		Total Ha	Pct of Yld
Rif Occident	365,425	95	Presaharienn	315,285	95
Rif Oriental	108,174	95	Saharienne	0	0
Oriental	374,442	95			
Moyen Sebou	578,842	95			
Gharb-Mamour	399,855	95			
Moyen Atlas	508,434	95			
Haut Atlas C	464,279	95			
Haouz-Tadla	451,721	95			
Chaouia	64,984	95			
Secteur Atla	1,128,695	95			

TABLE 18 - INPUT TABLE FOR BENEFITS ACCRUING FROM FORESTS MANAGED SO AS TO IMPROVE PRODUCTIVITY

M A N A G E D F O R E S T S

Enter Total Hectares Managed and Percent of Normal Yield Obtained

--	Total Ha	Pct of Yld		Total Ha	Pct of Yld
Rif Occident	0	110	Presaharienn	0	110
Rif Oriental	0	110	Saharienne	0	110
Oriental	0	110			
Moyen Sebou	0	110			
Gharb-Mamour	0	110			
Moyen Atlas	0	110			
Haut Atlas C	0	110			
Haouz-Tadla	0	110			
Chaouia	0	110			
Secteur Atla	0	110			

TABLE 19 - INPUT TABLE FOR BASIC REFORESTRATION (22,000 HA) SCENARIO

COMMERCIAL PLANTATIONS			
Number of Hectares Planted Per Year			
Rif Occid	3 000	Presahari	500
Rif orien	2 500	Saharienn	20
Oriental	2 000		
Moyen Seb	2 500		
Gharb Mam	3 500		
Moyen Atl	2 500		
Haut Atla	2 000		
Haouz-Tad	1 000		
Chaouia	500		
Secteur A	2 000		

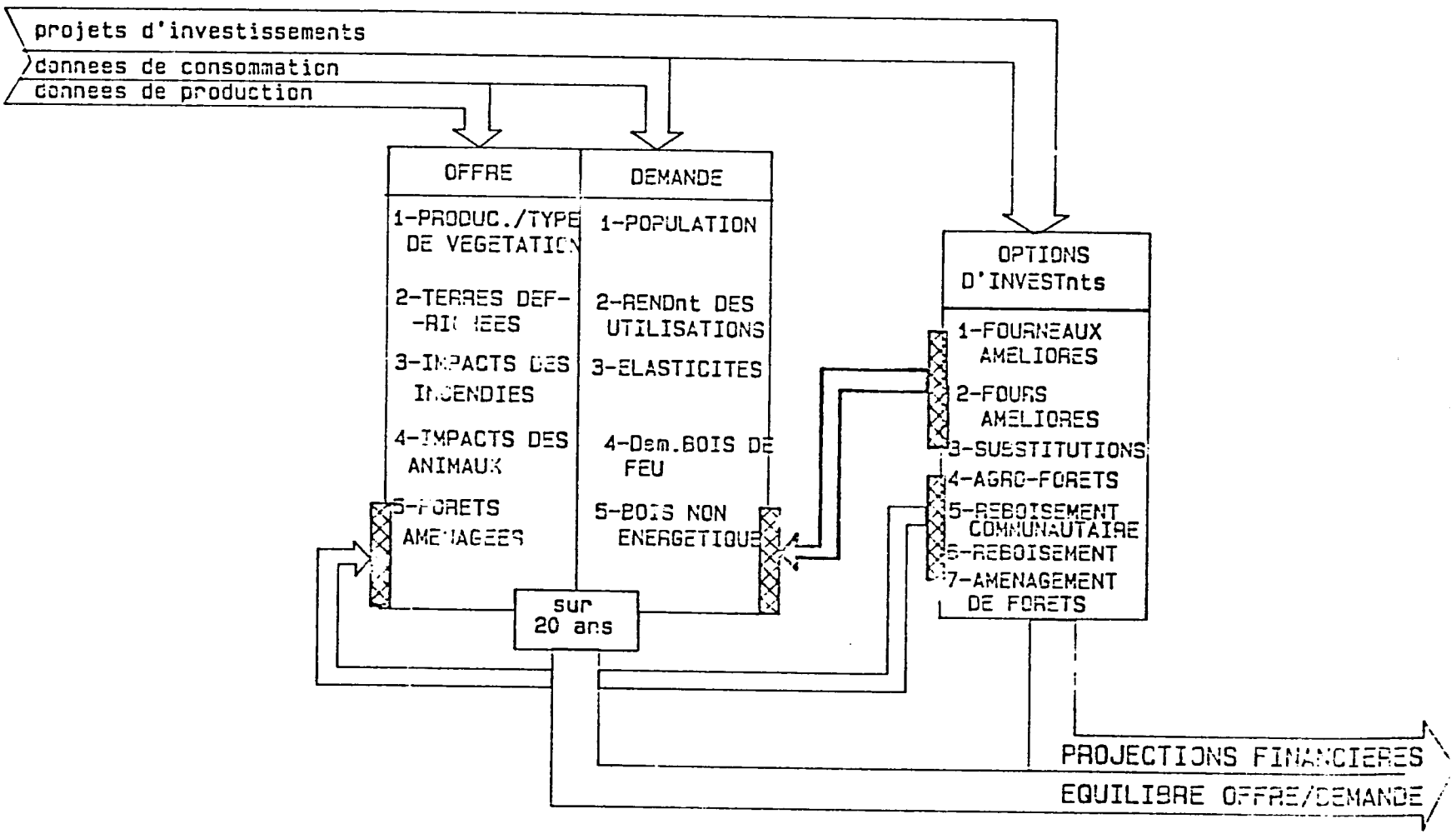
TABLE 20 - INPUT TABLE TO FIX PARAMETERS OF BASIC REFORESTRATION PROGRAM

C O M M E R C I A L P L A N T A T I O N S	
ENTER START YEAR OF PROGRAM :	1
ENTER END YEAR OF PROGRAM :	20
ENTER YIELD PER HA(M3):	4,5
ENTER ESTABLISHMENT COST PER HECTARE :	690
ENTER RECURRENT COSTS PER HECTARE :	50
Press Return to Input Number of Hectares Established Annually in Each Region	Press [RETURN]
FIRST YEAR PROGRAM INVESTMENT COSTS ARE :	25 662 620Dhs
ANNUAL RECURRENT COSTS ARE :	25 662 620Dhs
Press Return to REVISE or LOAD Project Data	Press [RETURN]

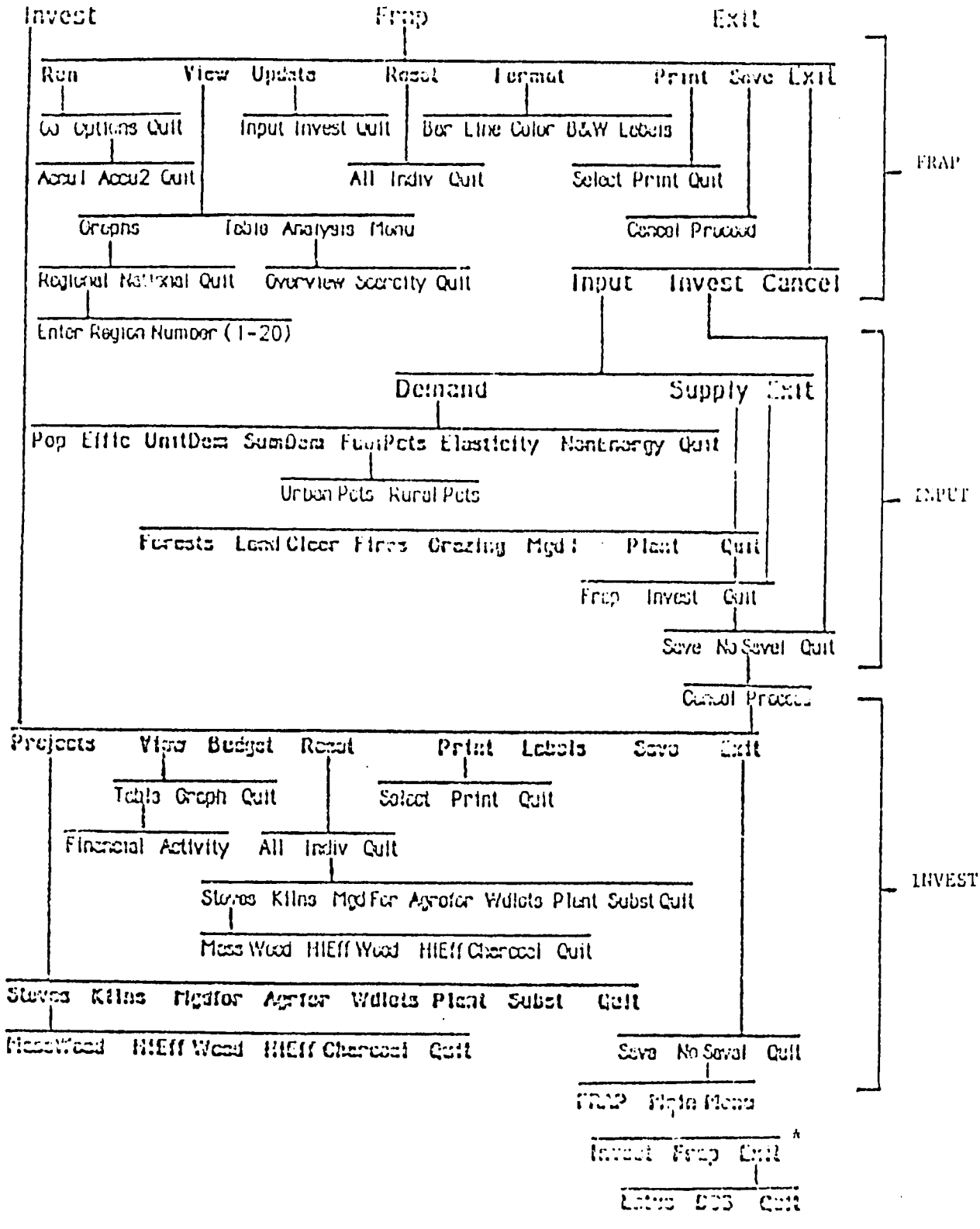
F I G U R E S

FIGURE 1 - LOGICAL DIAGRAM

ANALYSE ET PLANIFICATION DES RESSOURCES FORESTIERES (A.P.R.F./ F.R.A.P.)



FRAP MENU SYSTEM FLOWCHART



* This menu is identical to the menu at the top of this figure.

FIGURE 3

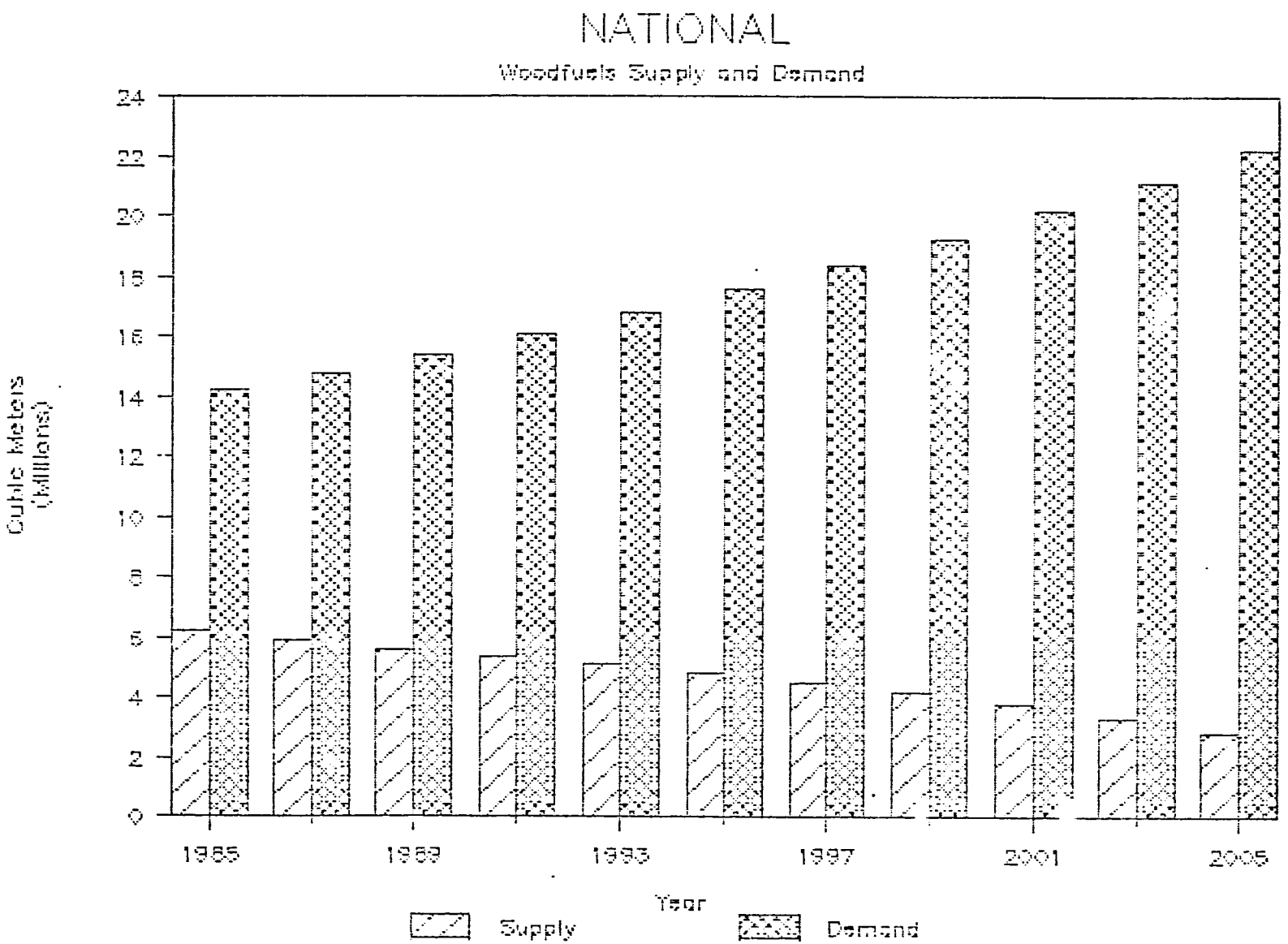

NATIONAL
Woodfuels Supply and Demand
Cubic Meters (Millions)
24
22
20
18
16
14
12
10
8
6
4
2
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 4

OVERVIEW

Status of Each Region (Base Case) in 2005

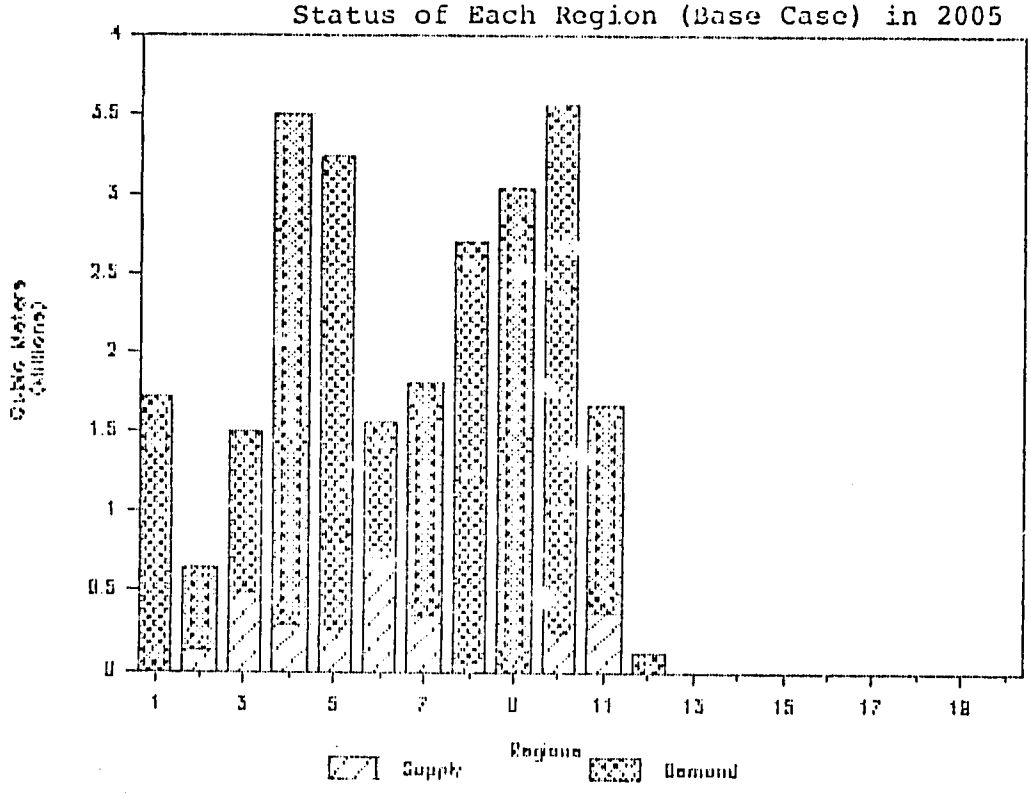


FIGURE 5

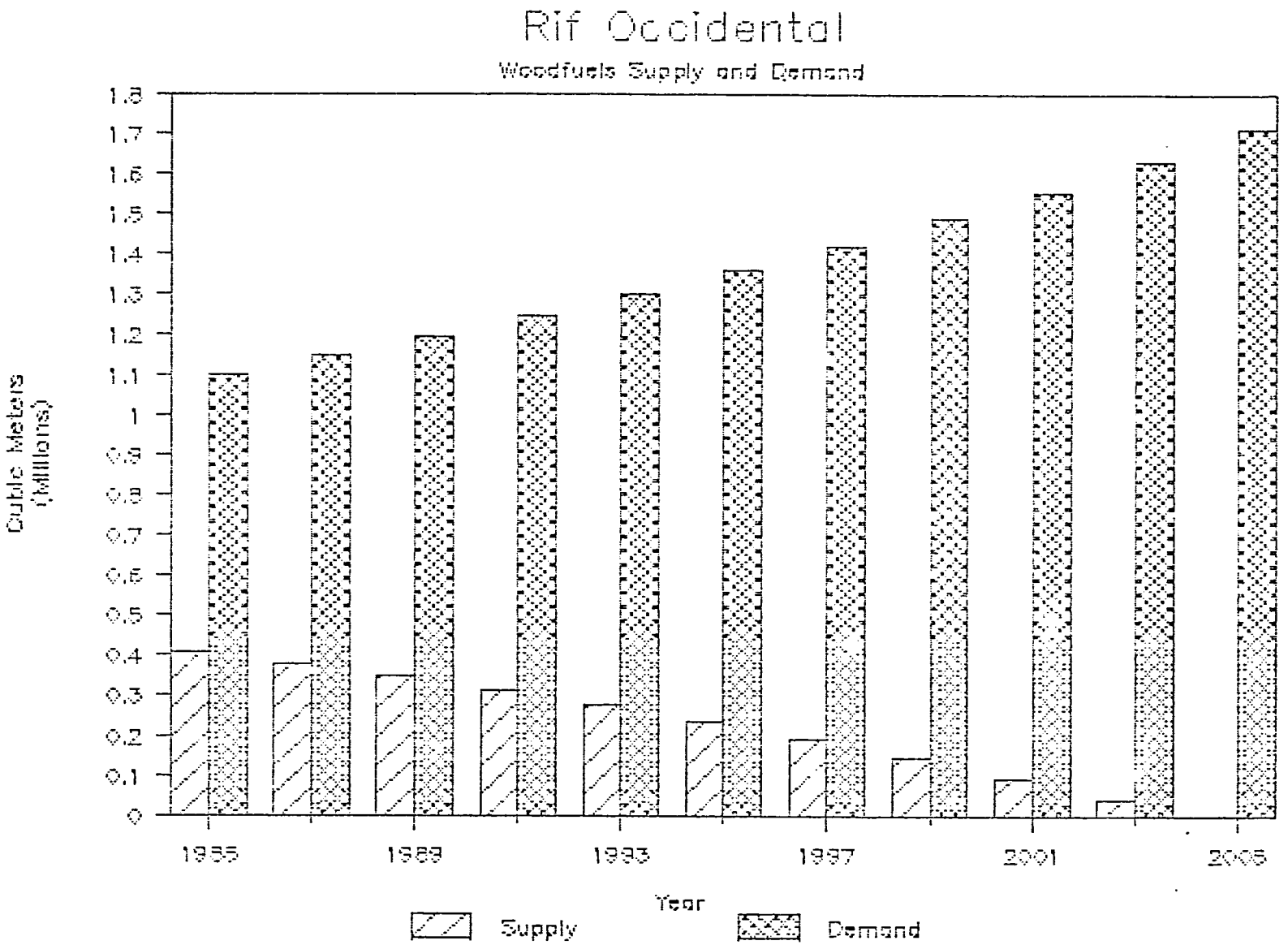

Rif Occidental
Woodfuels Supply and Demand
Cubic Meters (Millions)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 6

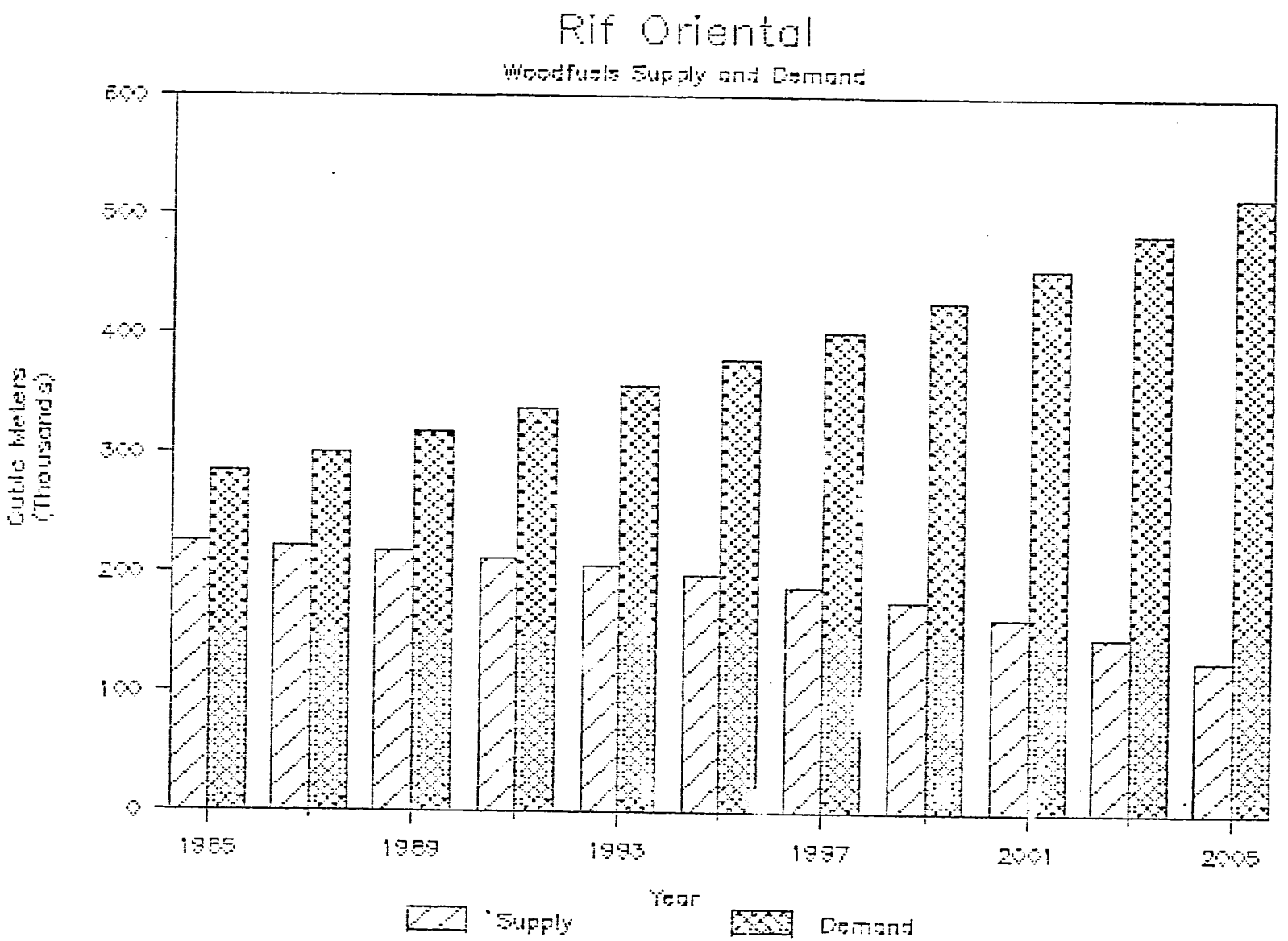

Rif Oriental
Woodfuels Supply and Demand
Cubic Meters (Thousands)
600
500
400
300
200
100
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 7

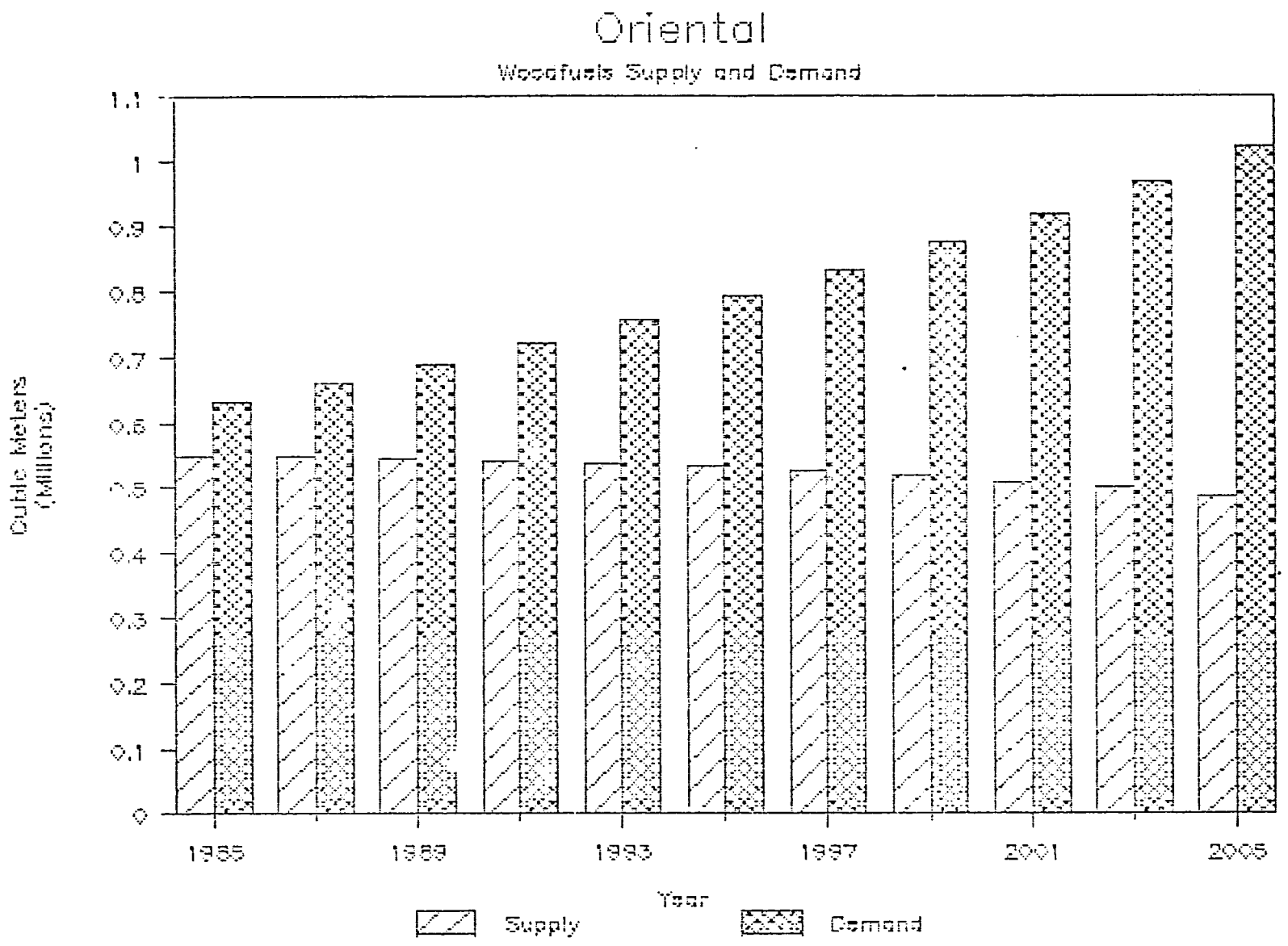

Oriental
Woodfuels Supply and Demand
Cubic Meters
(Millions)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 8

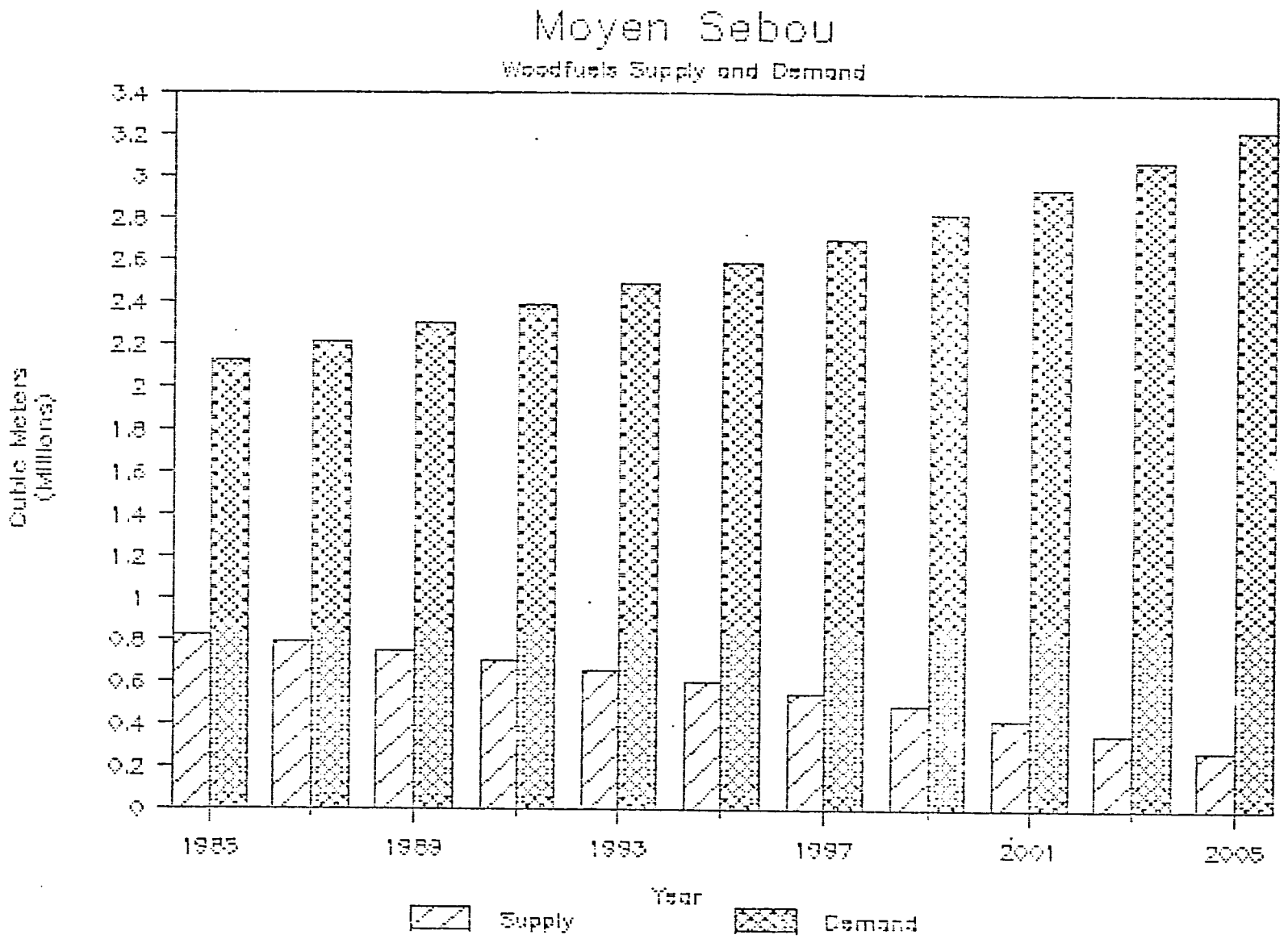

Moyen Sebou
Woodfuels Supply and Demand
Cubic Meters (Millions)
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 9

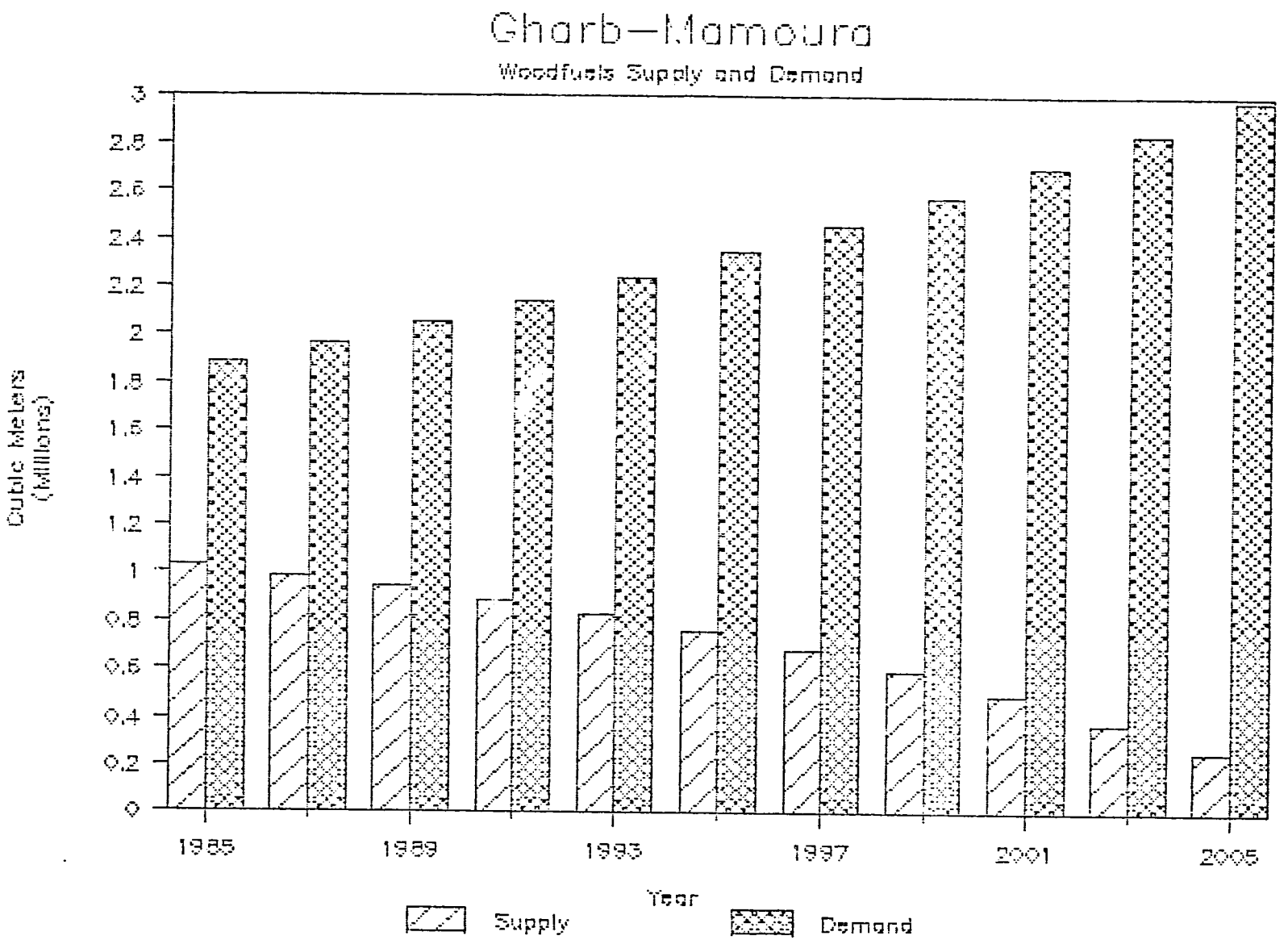

Gharb—Mamoura
Woodfuels Supply and Demand
Cubic Meters (Millions)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 10

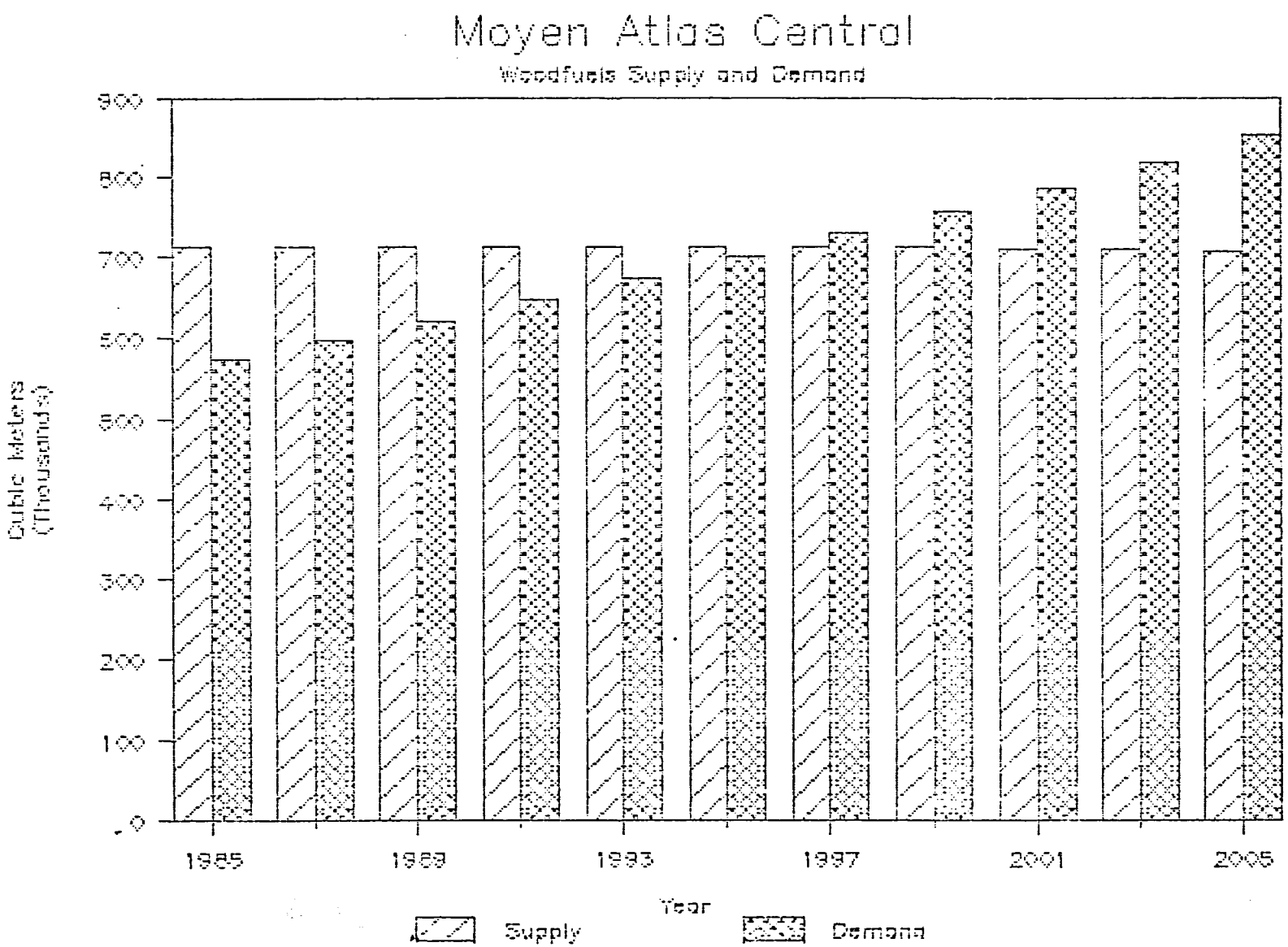

Moyen Atlas Central
Woodfuels Supply and Demand
900
800
700
600
500
400
300
200
100
0
Cubic Meters
(Thousands)
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 11

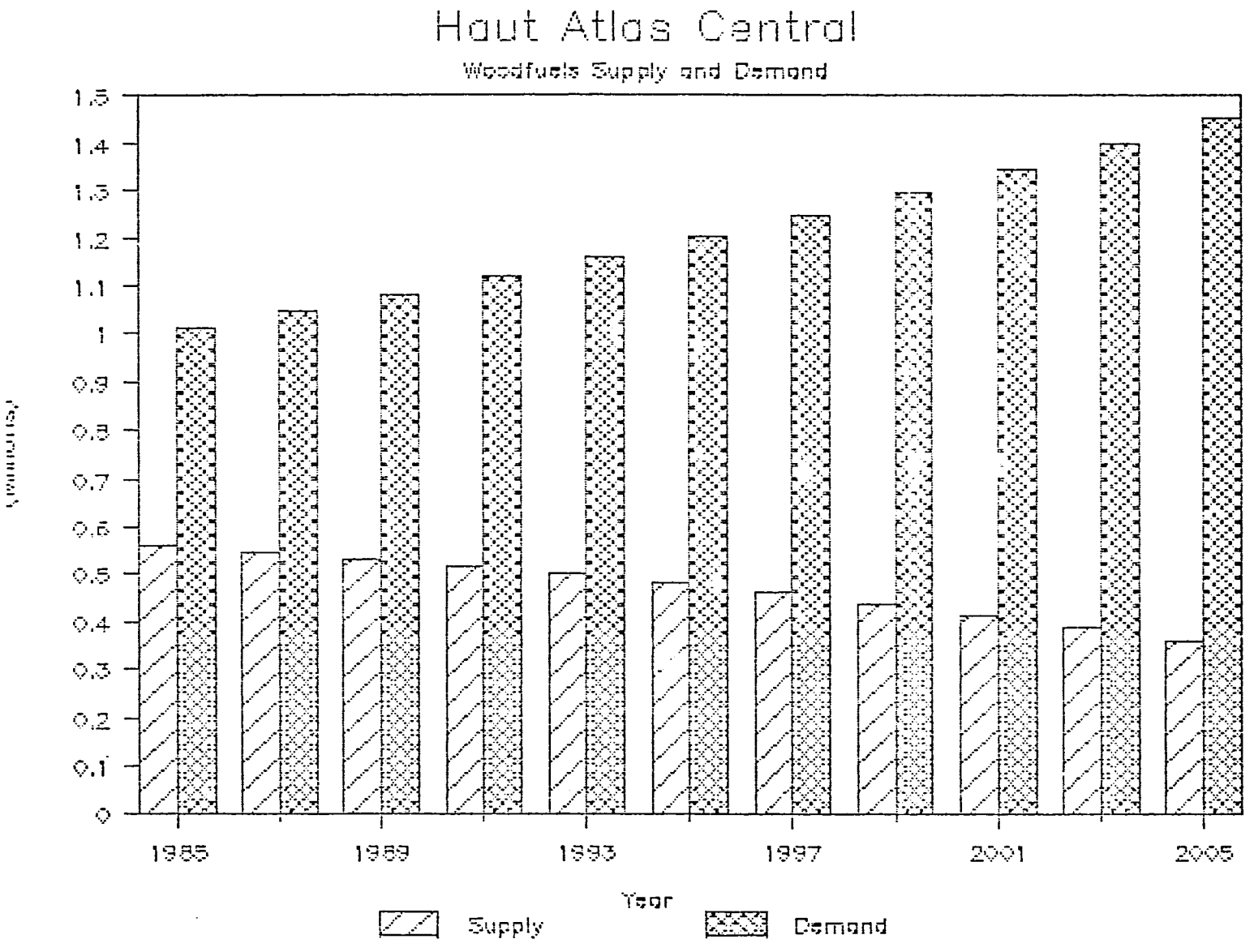

Haut Atlas Central
Woodfuels Supply and Demand
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 12

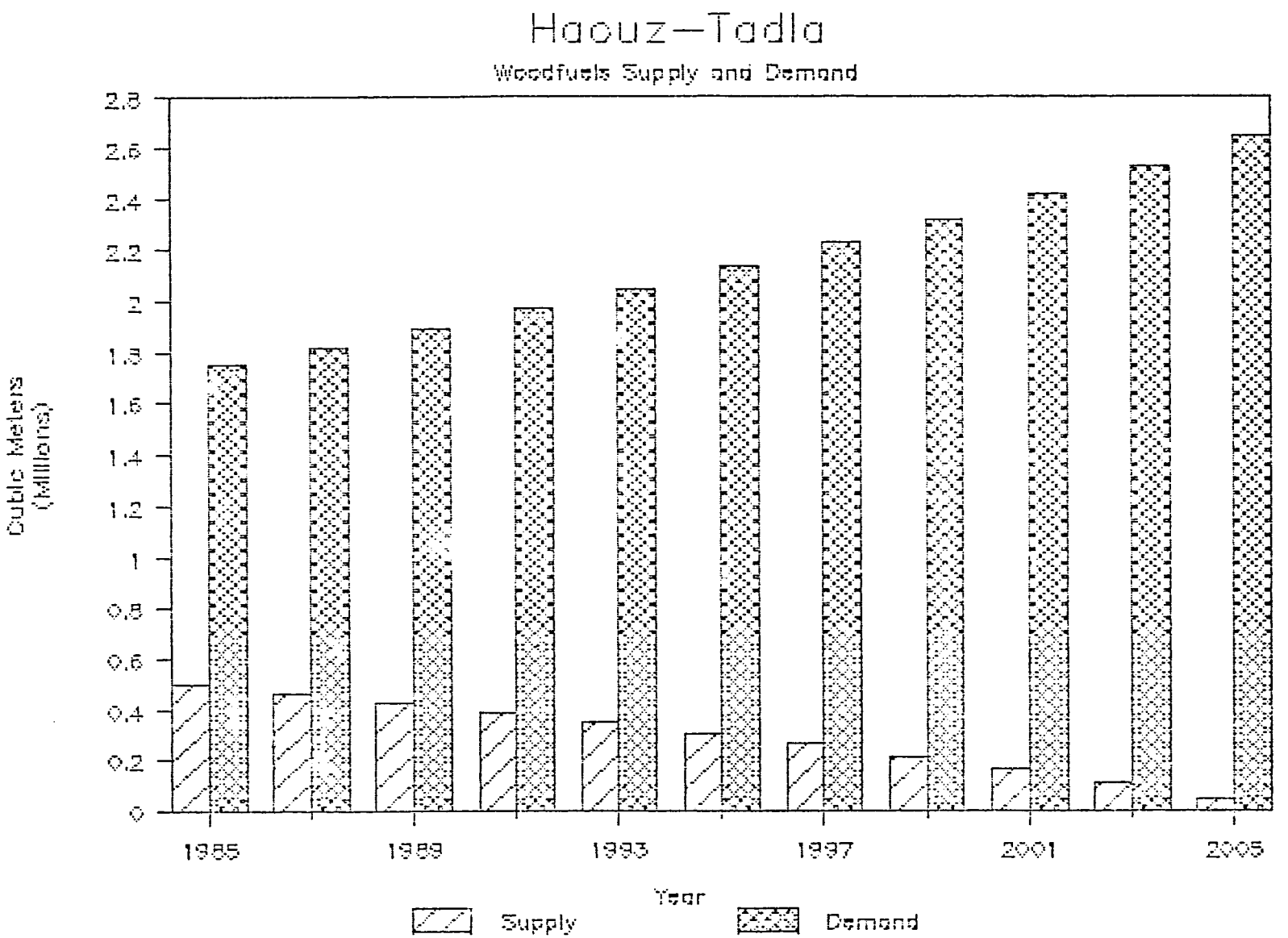

Haouz—Tadla
Woodfuels Supply and Demand
Cubic Meters (Millions)
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 13

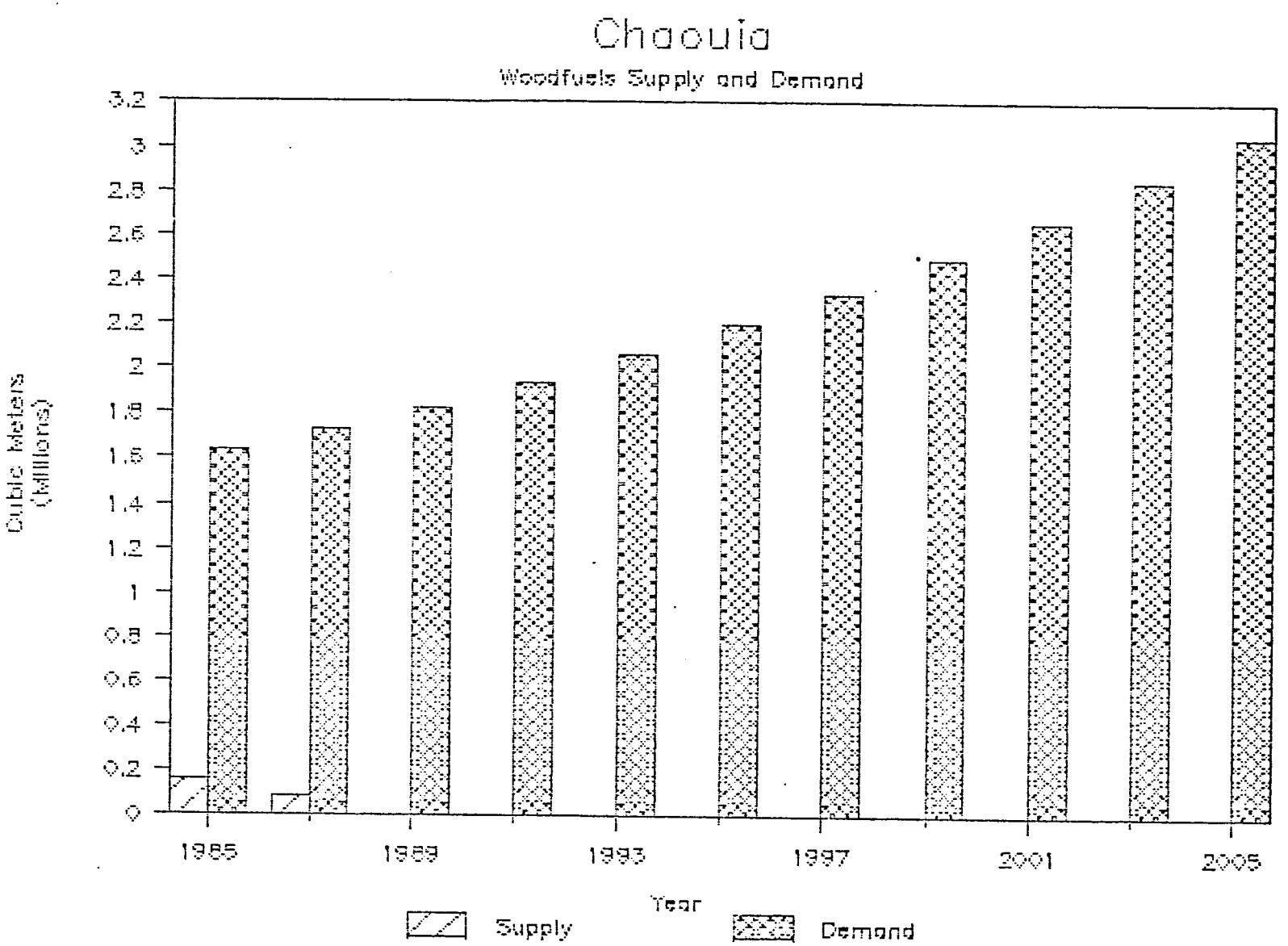

Chaouia
Woodfuels Supply and Demand
Cubic Meters (Millions)
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 14

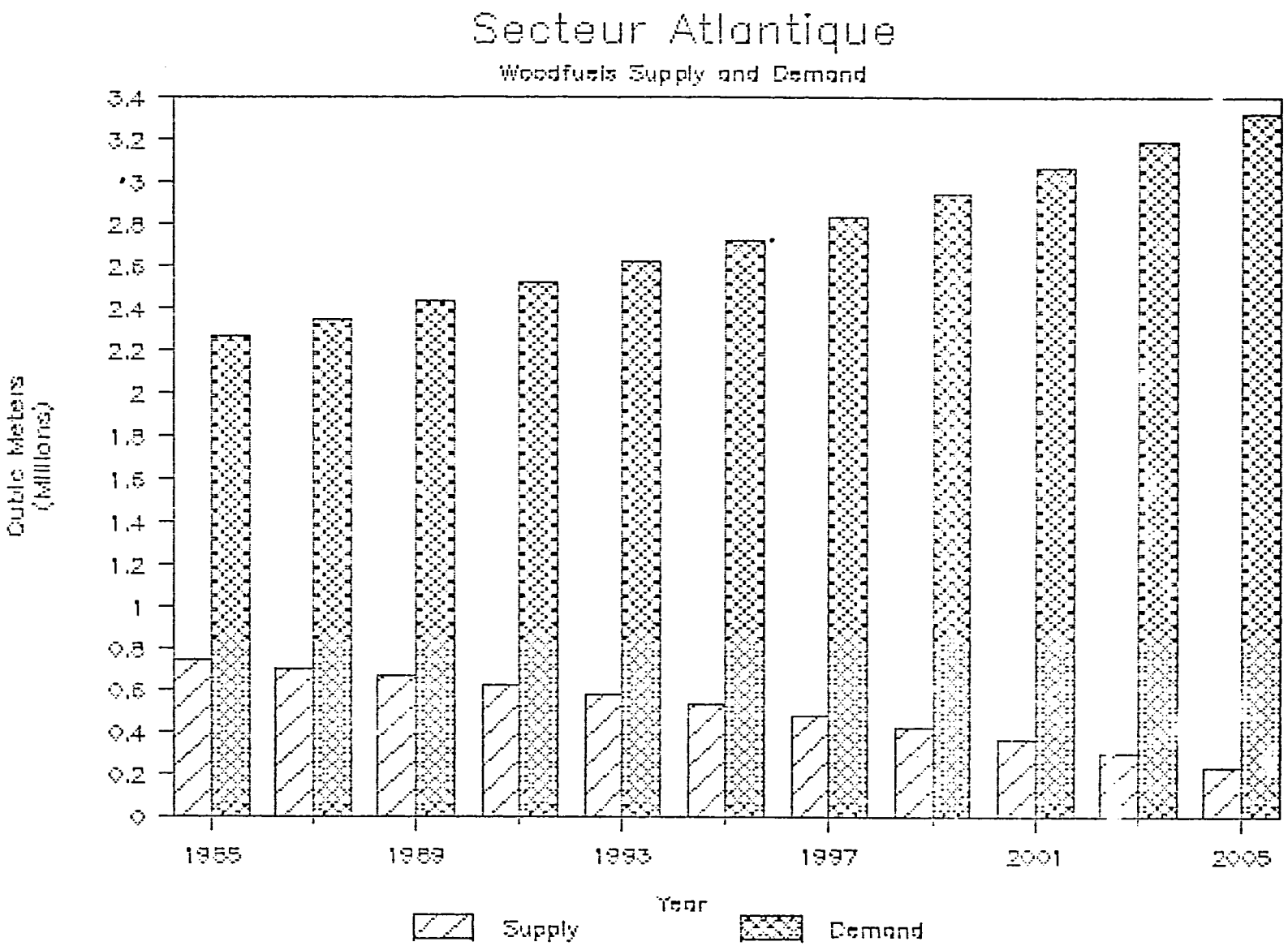

Secteur Atlantique
Woodfuels Supply and Demand
Cubic Meters (Millions)
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 15

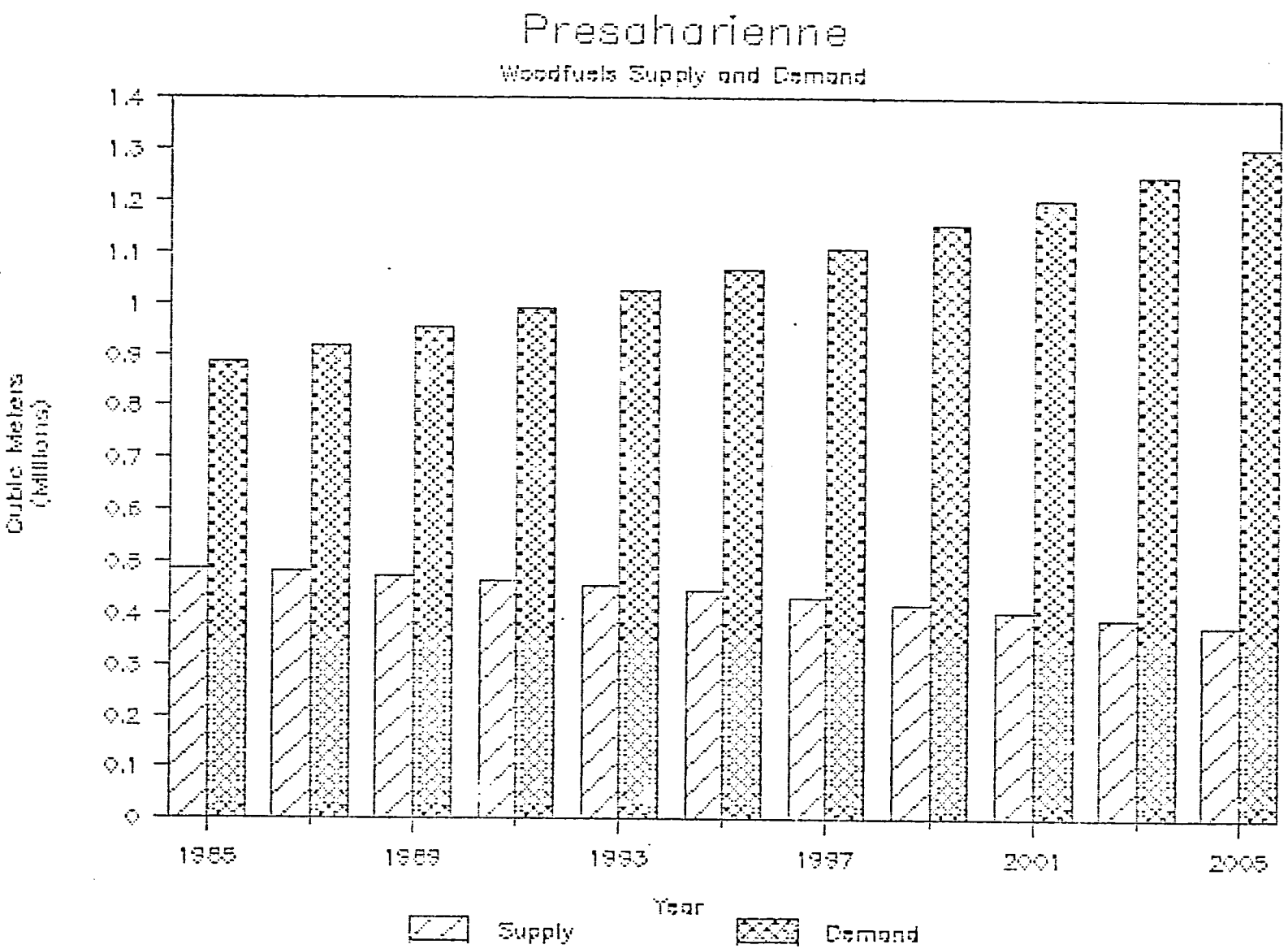

Presaharienne
Woodfuels Supply and Demand
Cubic Meters
(Millions)
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 16

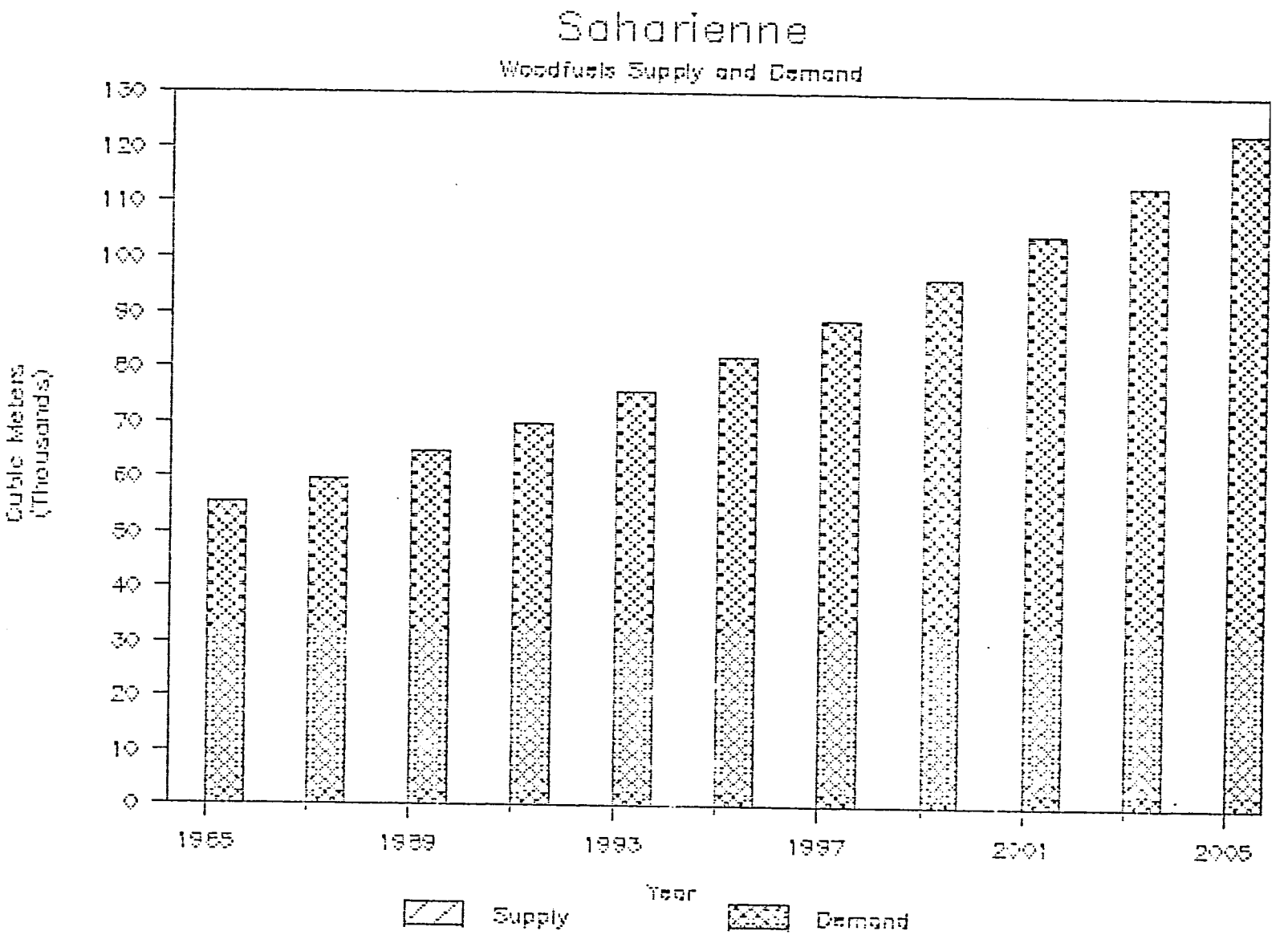
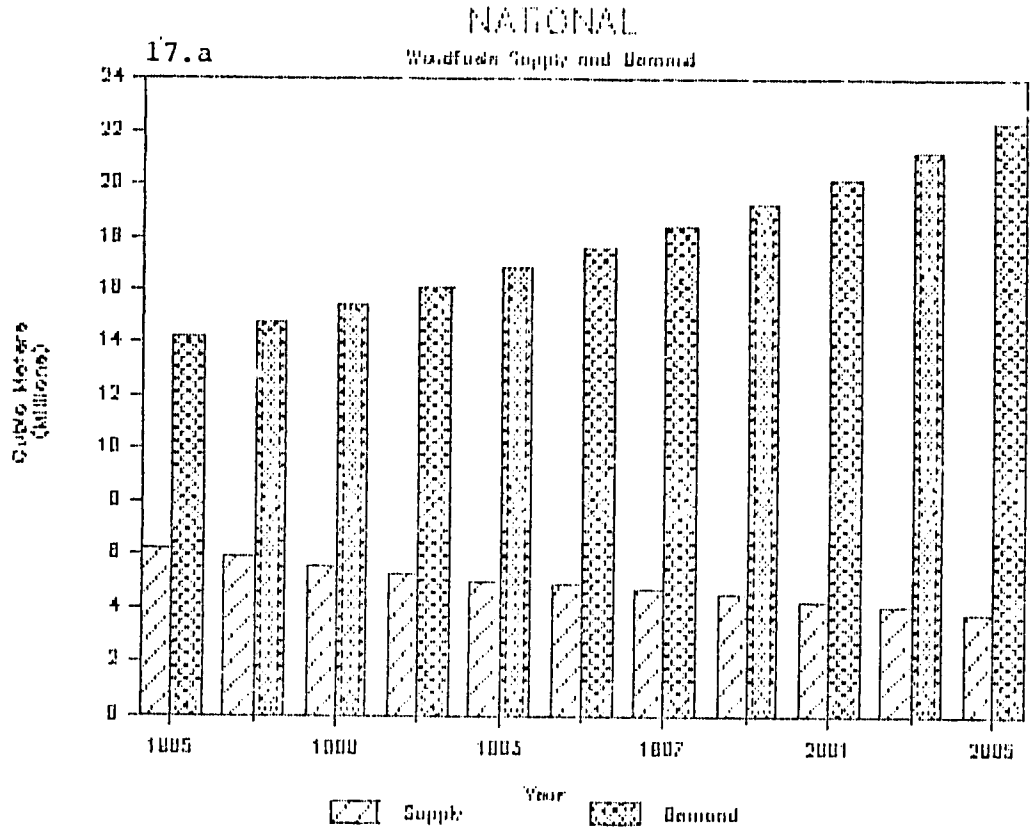
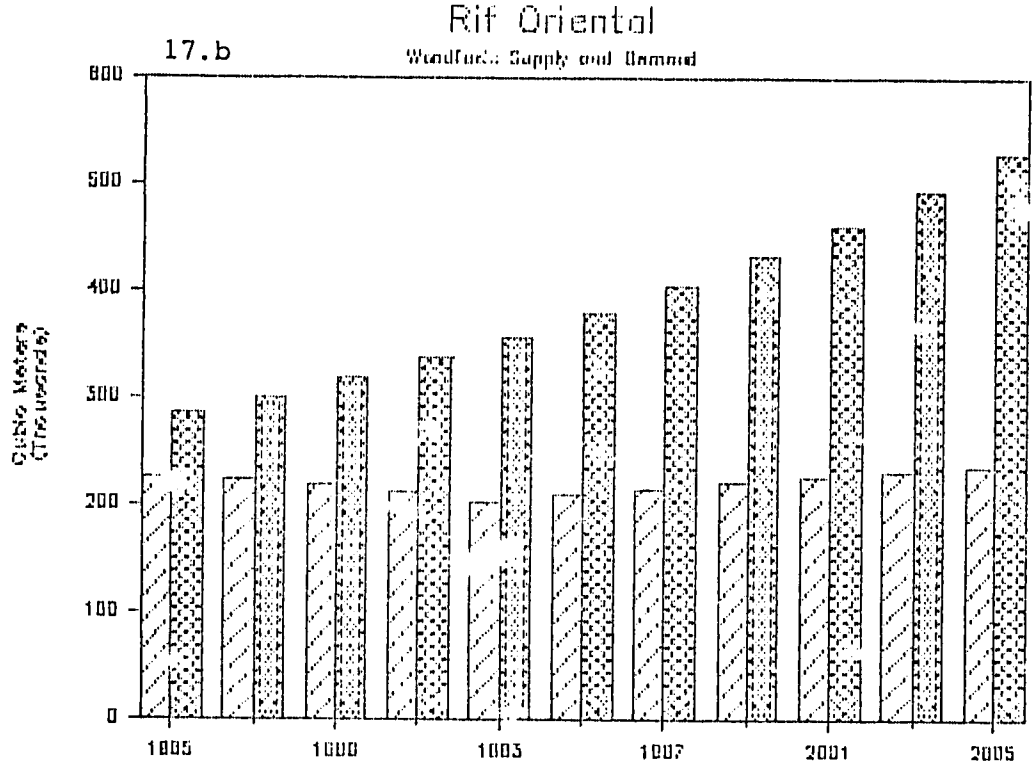
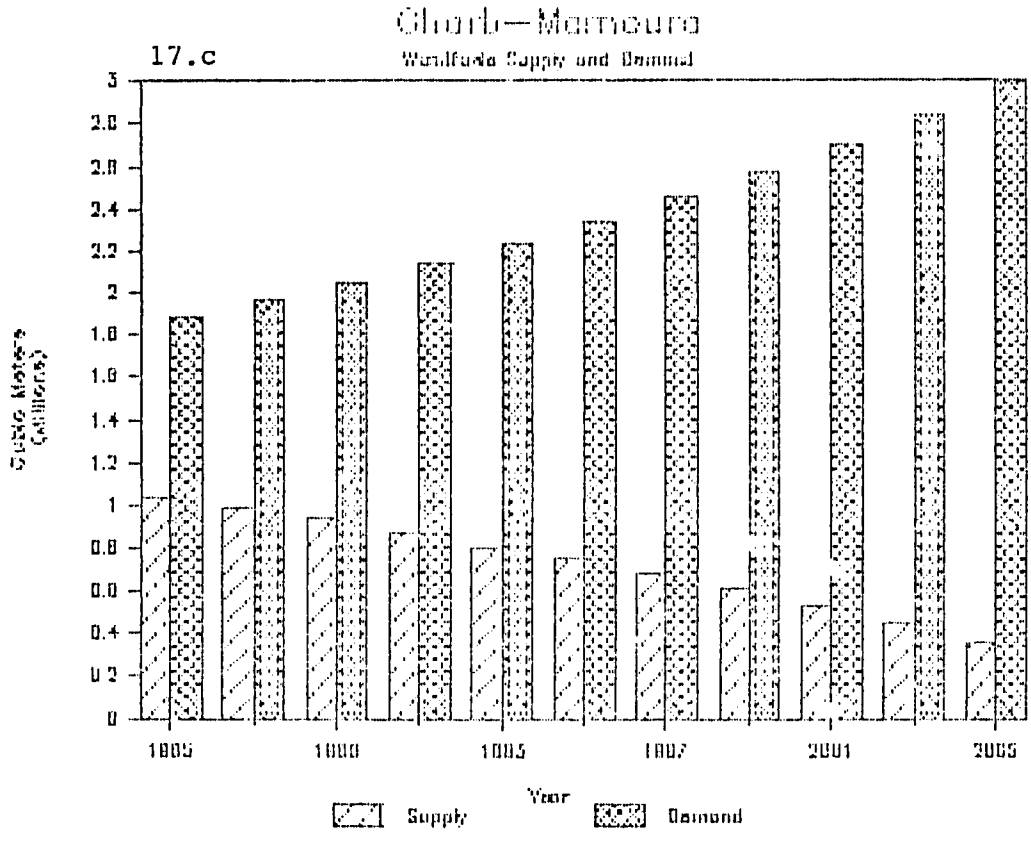

Saharienne
Woodfuels Supply and Demand
Cubic Meters (Thousands)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1985
1989
1993
1997
2001
2005
Year
Supply
Demand

FIGURE 17

IMPACT OF THE BASIC REFORESTRATION PROGRAM (REF1) ON WOODFUEL SUPPLY AND DEMAND






Gharb—Mamoura
17.c
Woodfuels Supply and Demand
Cubic Meters (Millions)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1990
1995
1997
2001
2005
Year
Supply
Demand

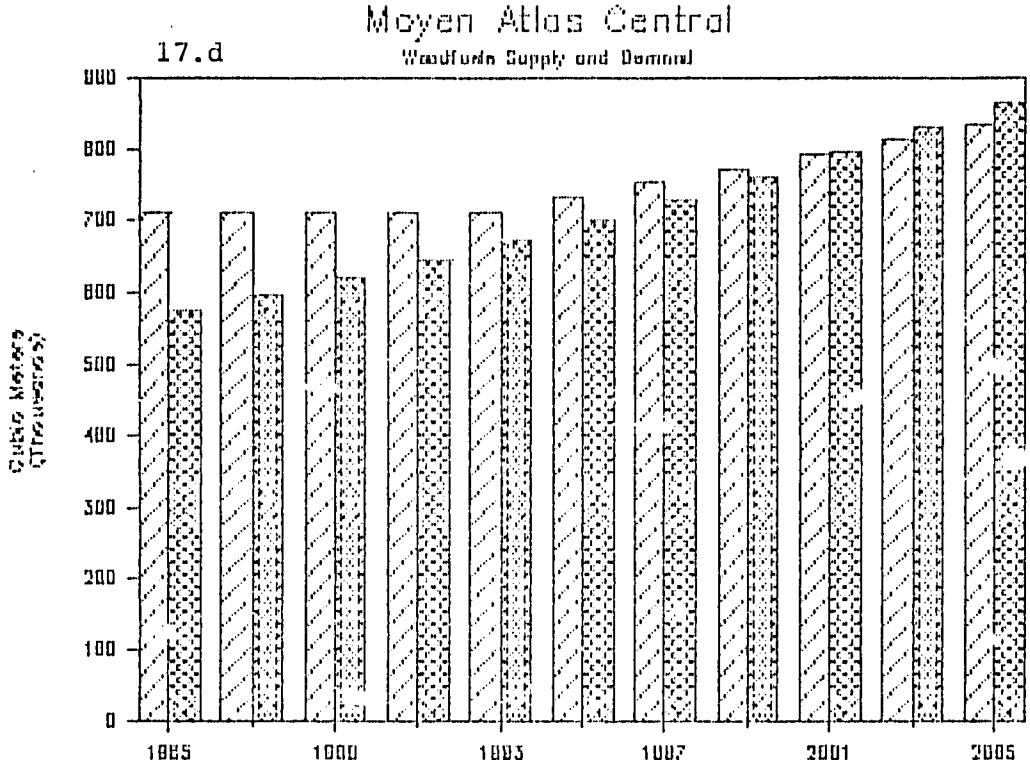
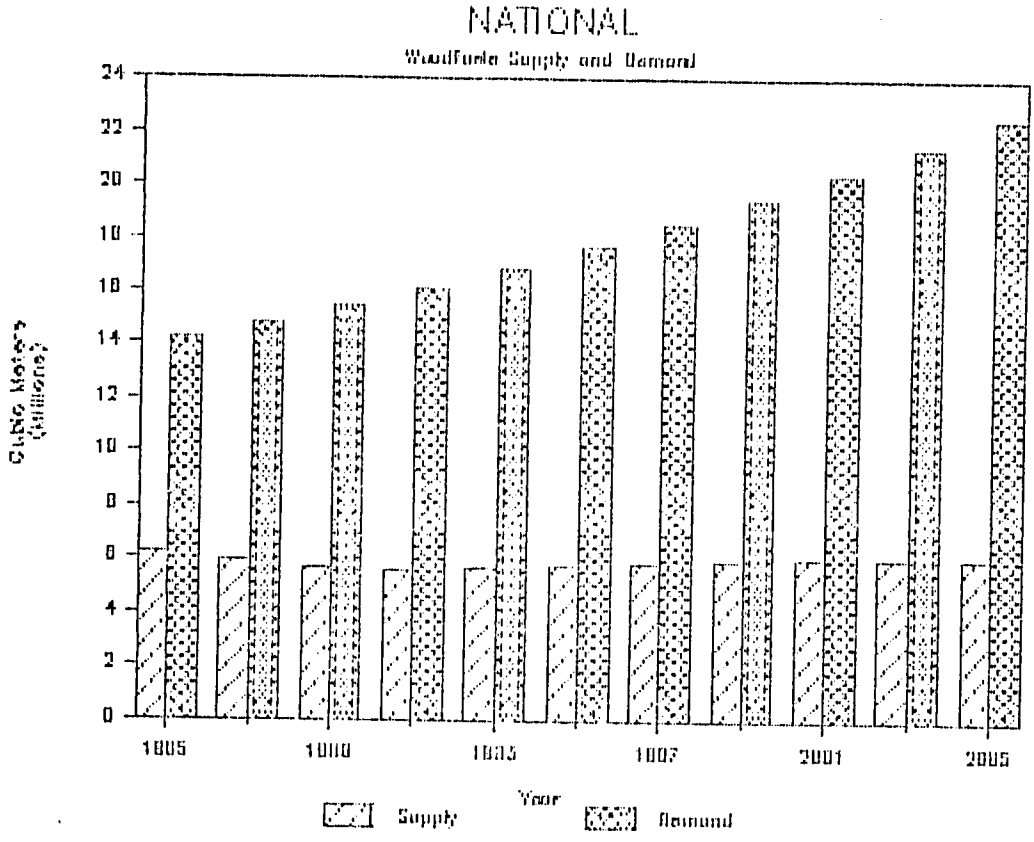

Moyen Atlas Central
17.d
Woodfuels Supply and Demand
Cubic Meters (Thousands)
900
800
700
600
500
400
300
200
100
0
1985
1990
1995
1997
2001
2005

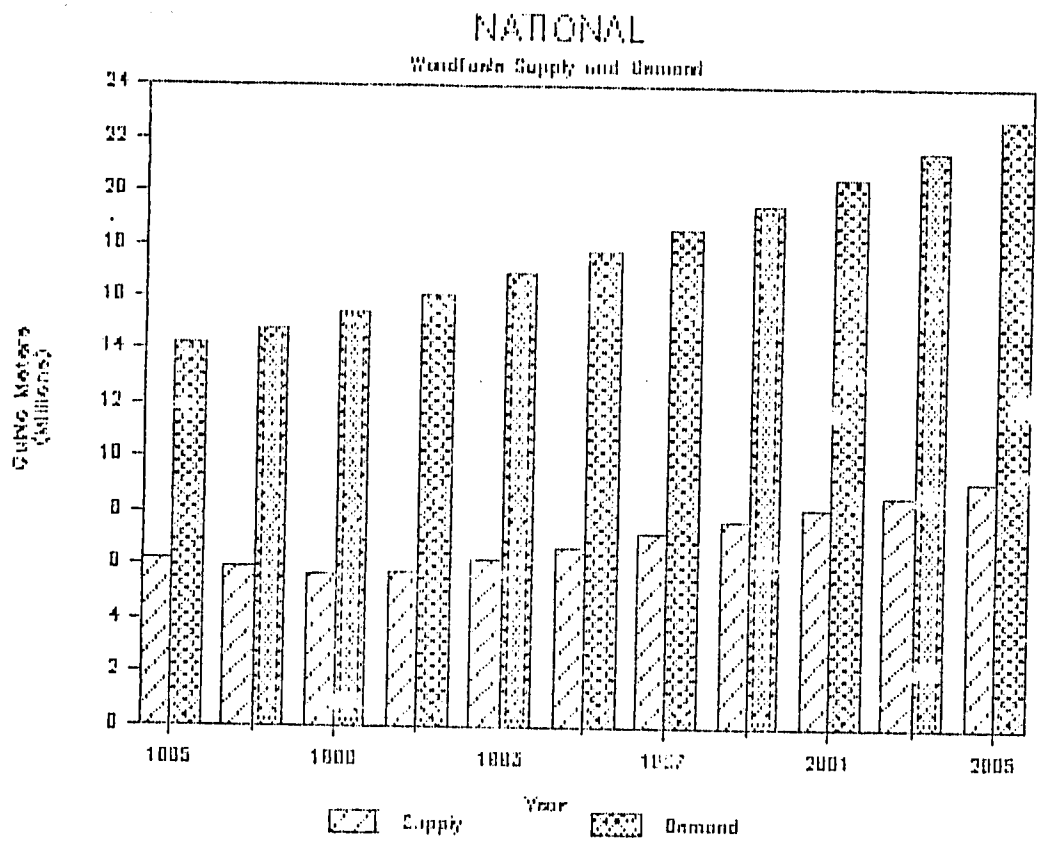
FIGURE 18

IMPACT OF THE BASIC REFORESTRATION PROGRAM INCLUDING SRIC TECHNOLOGY (REF2) ON WOODFUEL SUPPLY AND DEMAND



IMPACT OF THE BASIC REFORESTRATION PROGRAM DOUBLED AND SRIC TECHNOLOGY ON WOODFUEL SUPPLY AND DEMAND (REF3)

FIGURE 19



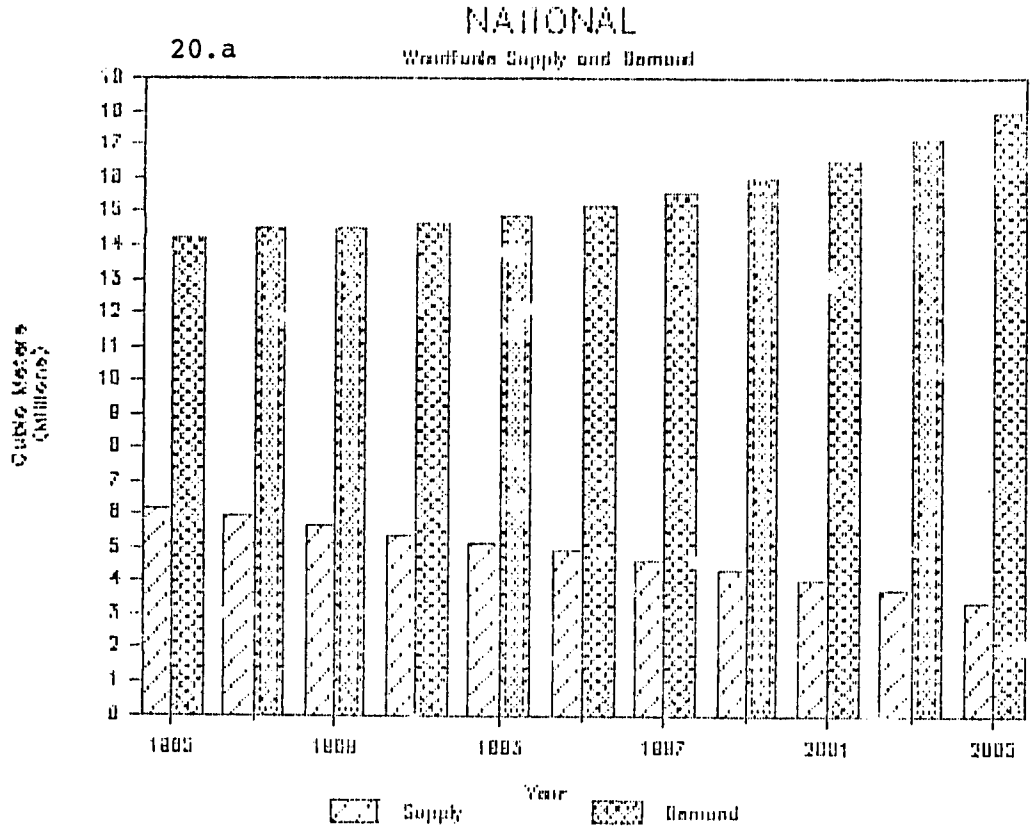
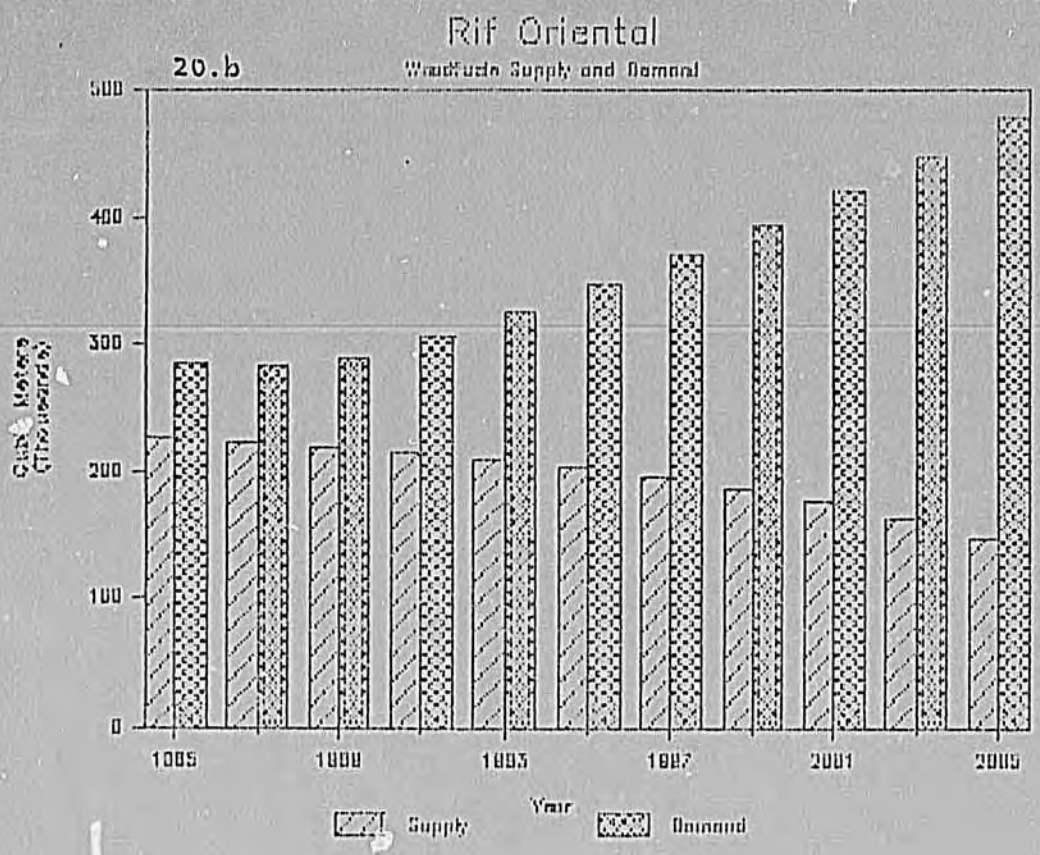
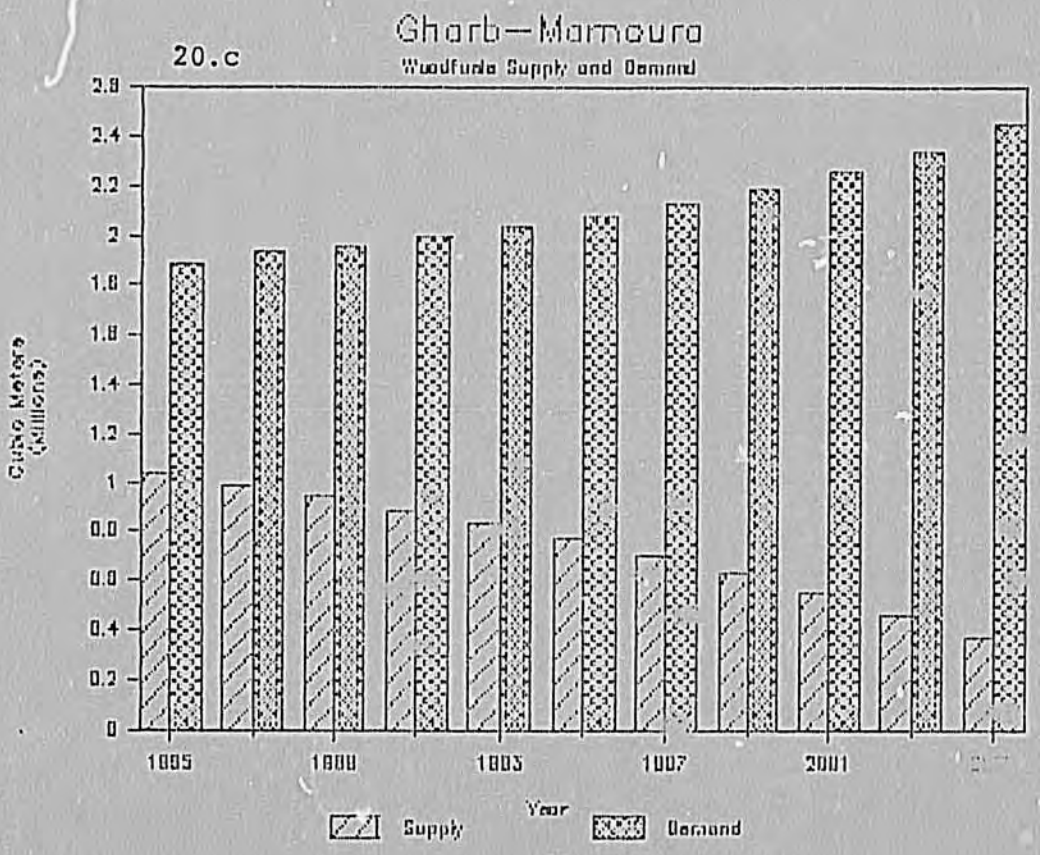
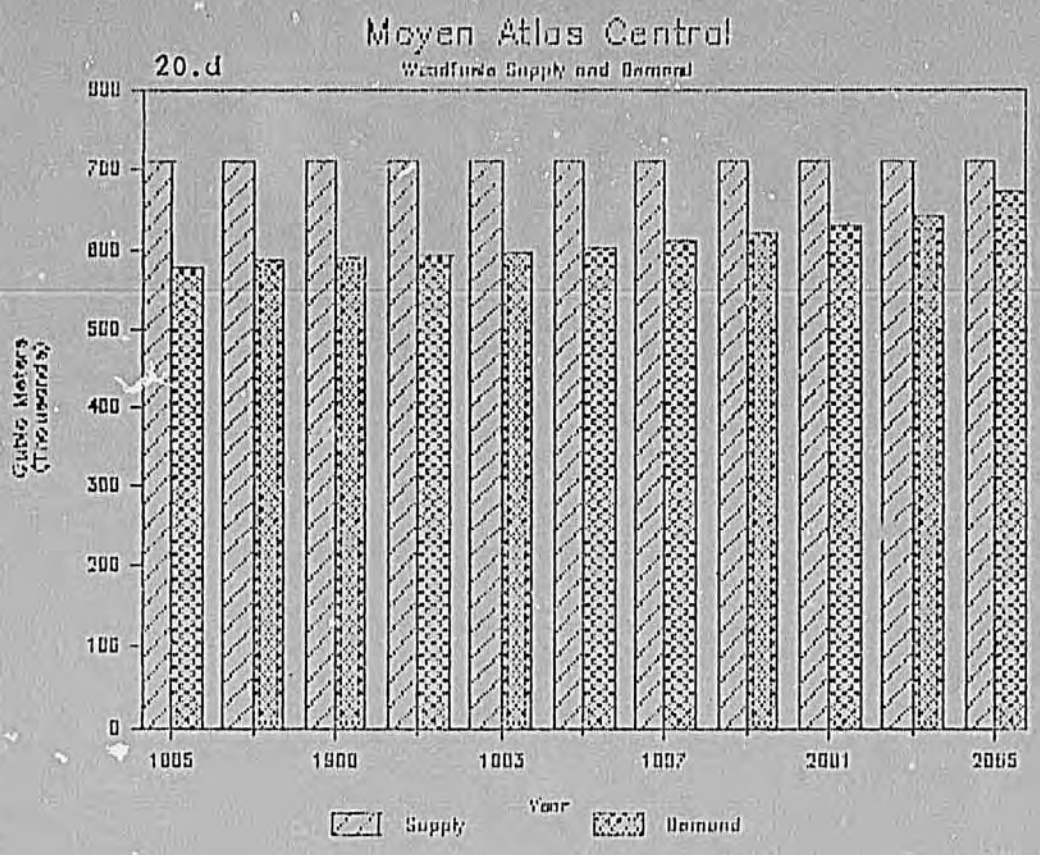


FIGURE 20

IMPACT OF IMPROVED COOKSTOVES ON WOODFUEL SUPPLY AND DEMAND (FA1)


Rif Oriental
20.b
Woodfuels Supply and Demand
500
400
300
200
100
0
Cubic Meters (Thousands)
1995
1999
2003
2007
2011
2015
Year
Supply
Demand


Gharb—Mamoura
20.c
Woodfuels Supply and Demand
2.8
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Cubic Meters (Millions)
1995
1999
2003
2007
2011
Year
Supply
Demand


Moyen Atlas Central
20.d
Woodfuels Supply and Demand
900
700
800
500
400
300
200
100
0
Cubic Meters
(thousands)
1985
1990
1995
1997
2001
2005
Year
Supply
Demand

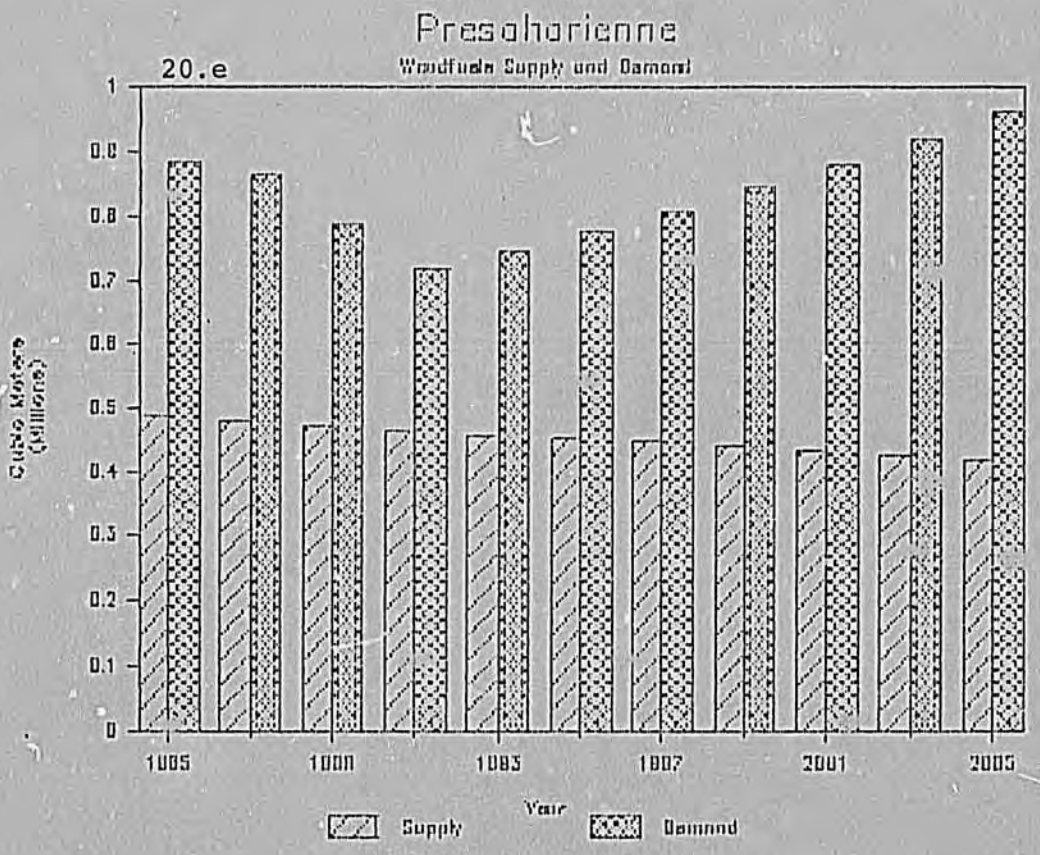
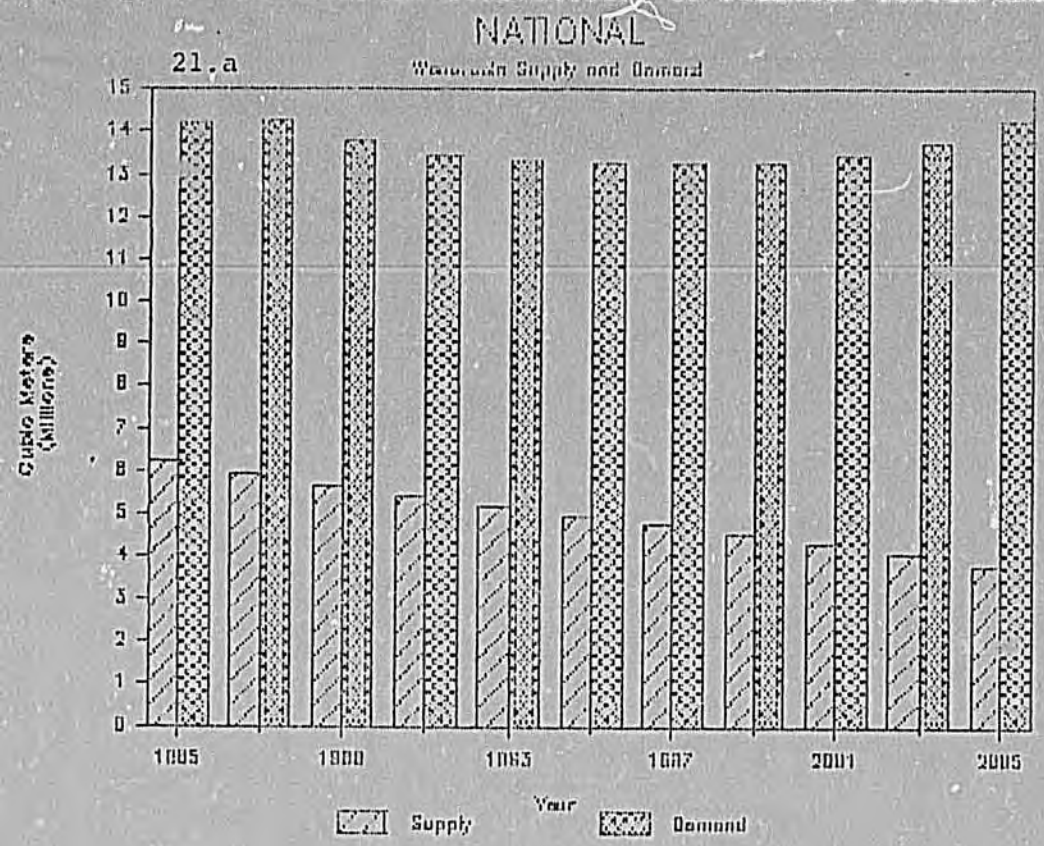
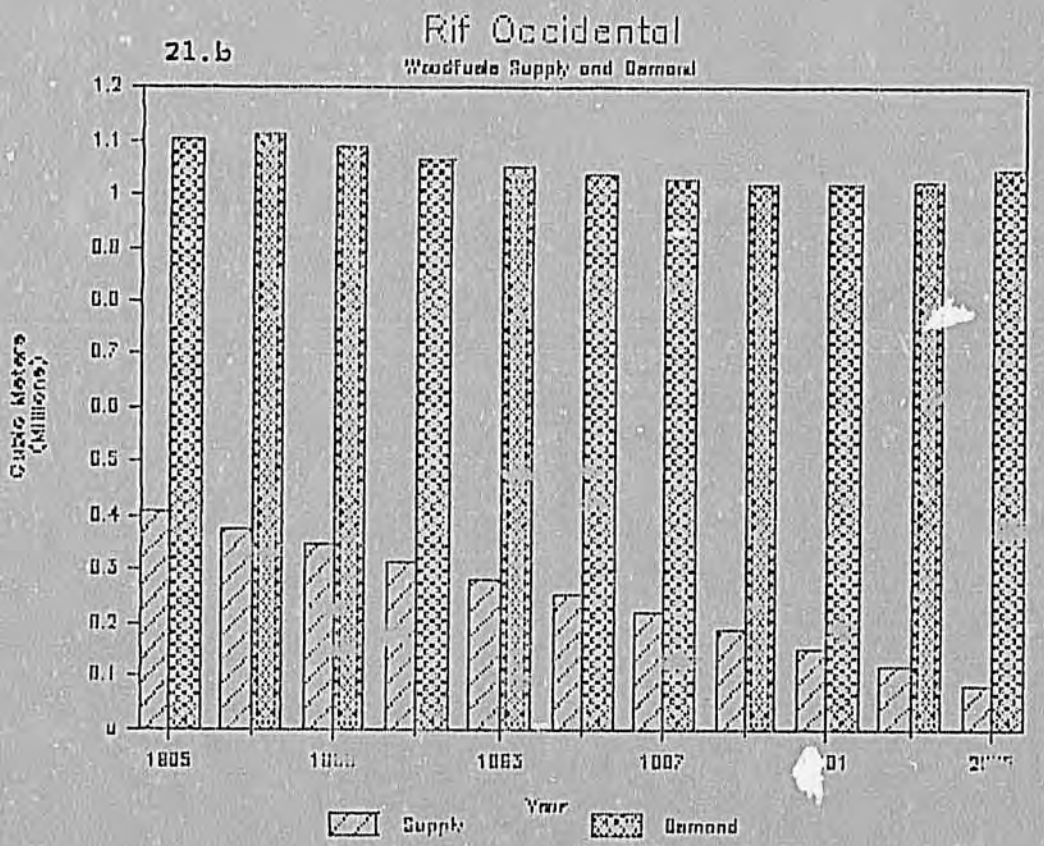
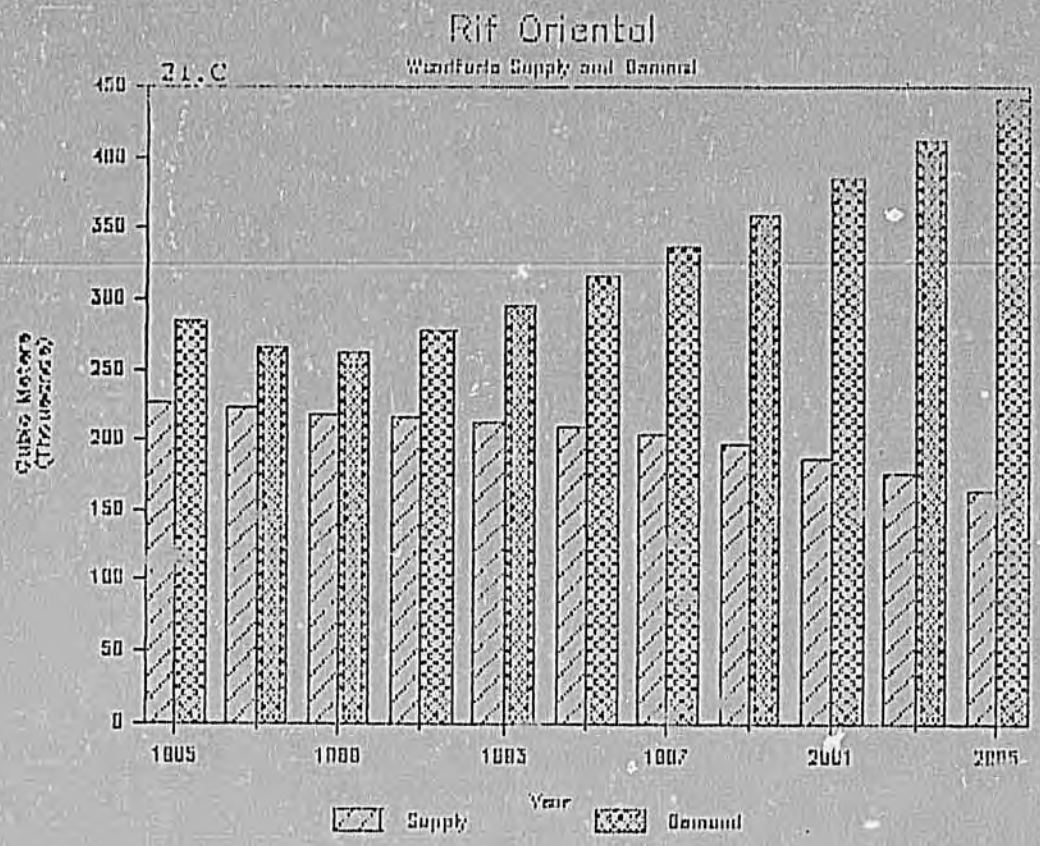
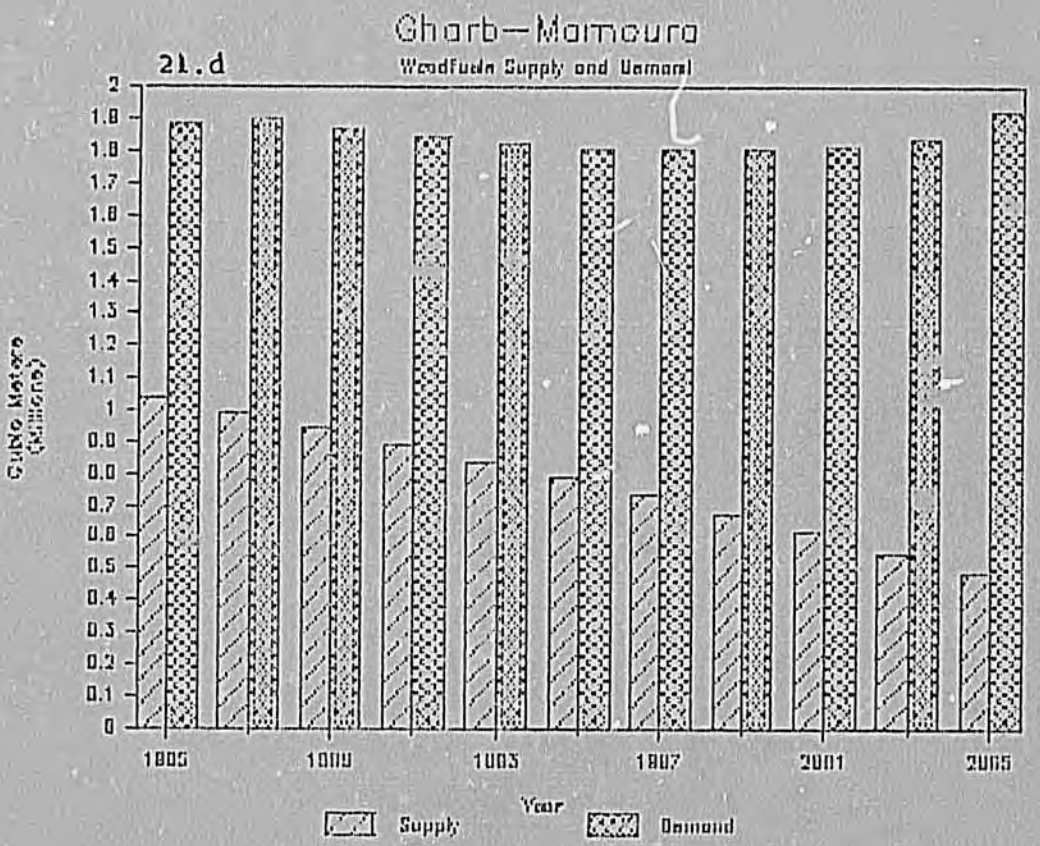

Presaharienne
20.e
Woodfuels Supply and Demand
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Cubic Meters
(millions)
1985
1990
1995
1997
2001
2005
Year
Supply
Demand

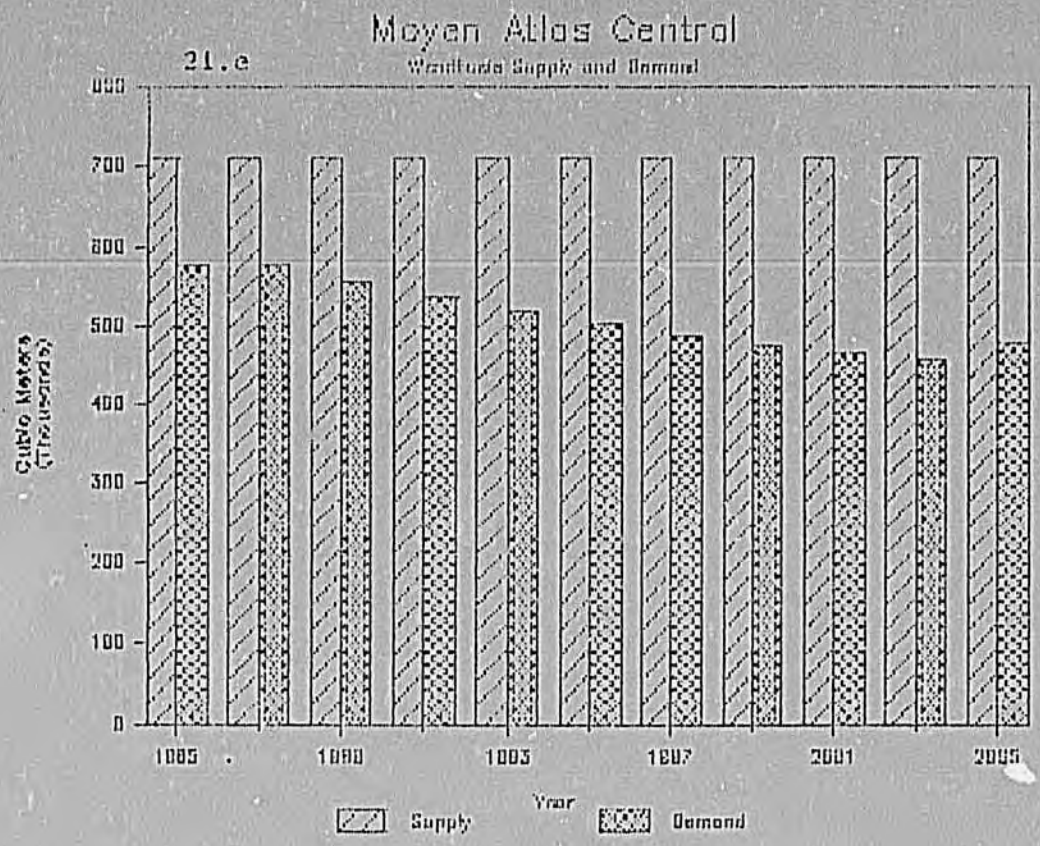
FIGURE 21 - IMPACT OF NON-WOODFUEL SUBSTITUTION ON FUELWOOD SUPPLY AND DEMAND(Su61)






Rif Oriental
21.c
Woodfuels Supply and Demand
450
400
350
300
250
200
150
100
50
0
Cubic Meters
1995
1999
2003
2007
2011
2015
Year
Supply
Demand


Gharb—Mamoura
21.d
Woodfuels Supply and Demand
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Cubic Meters
1995
1999
2003
2007
2011
2015
Year
Supply
Demand


Moyen Atlas Central
21.e
Woodfuels Supply and Demand
Cubic Meters (Thousands)
0
100
200
300
400
500
600
700
800
900
1995
1999
2003
2007
2011
2015
Year
Supply
Demand

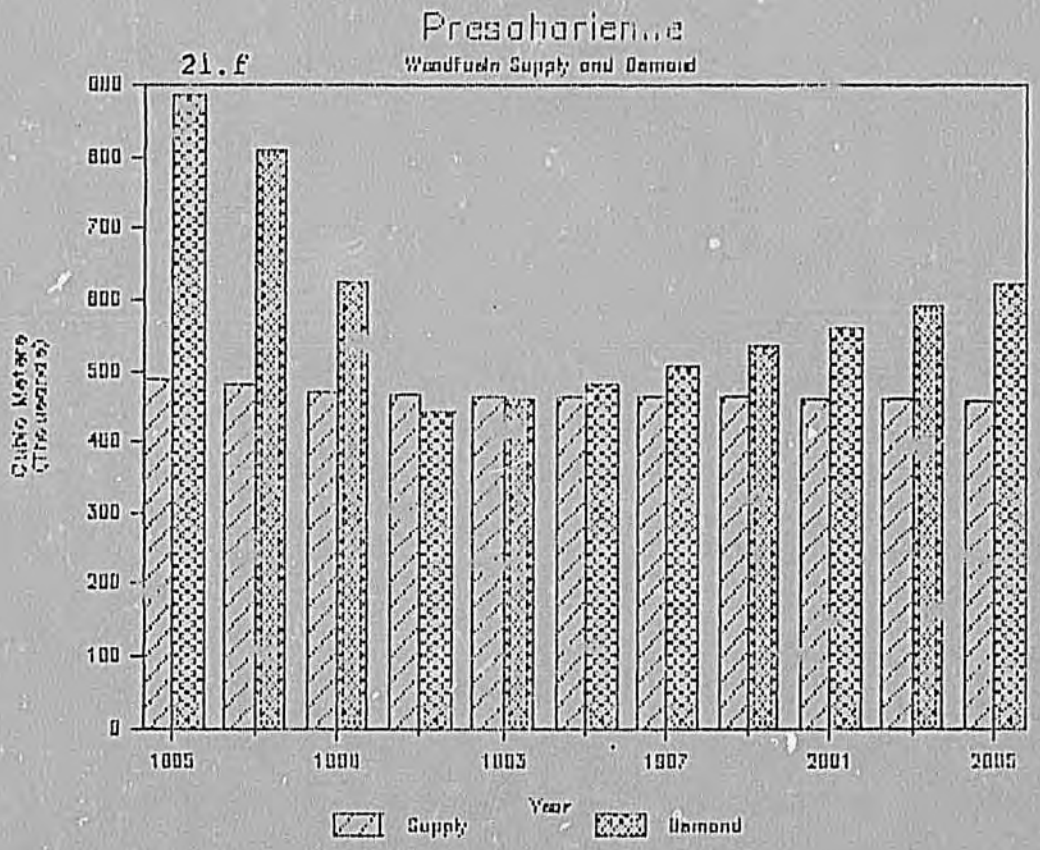
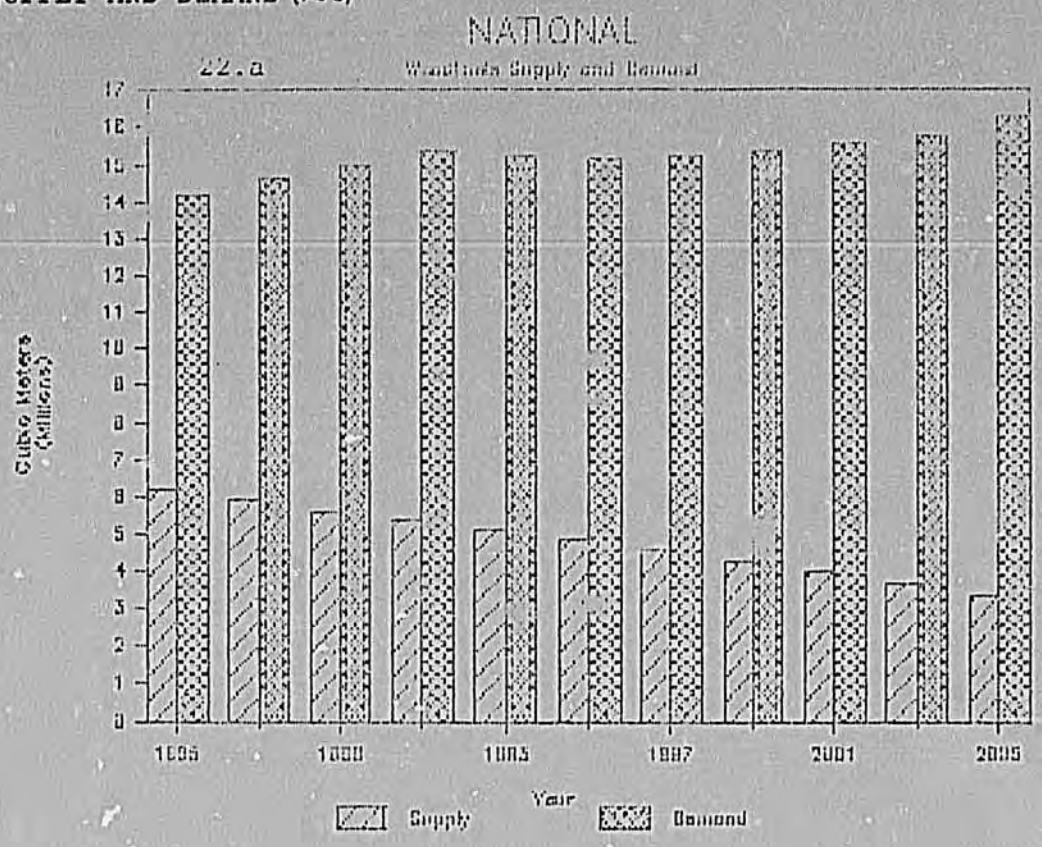
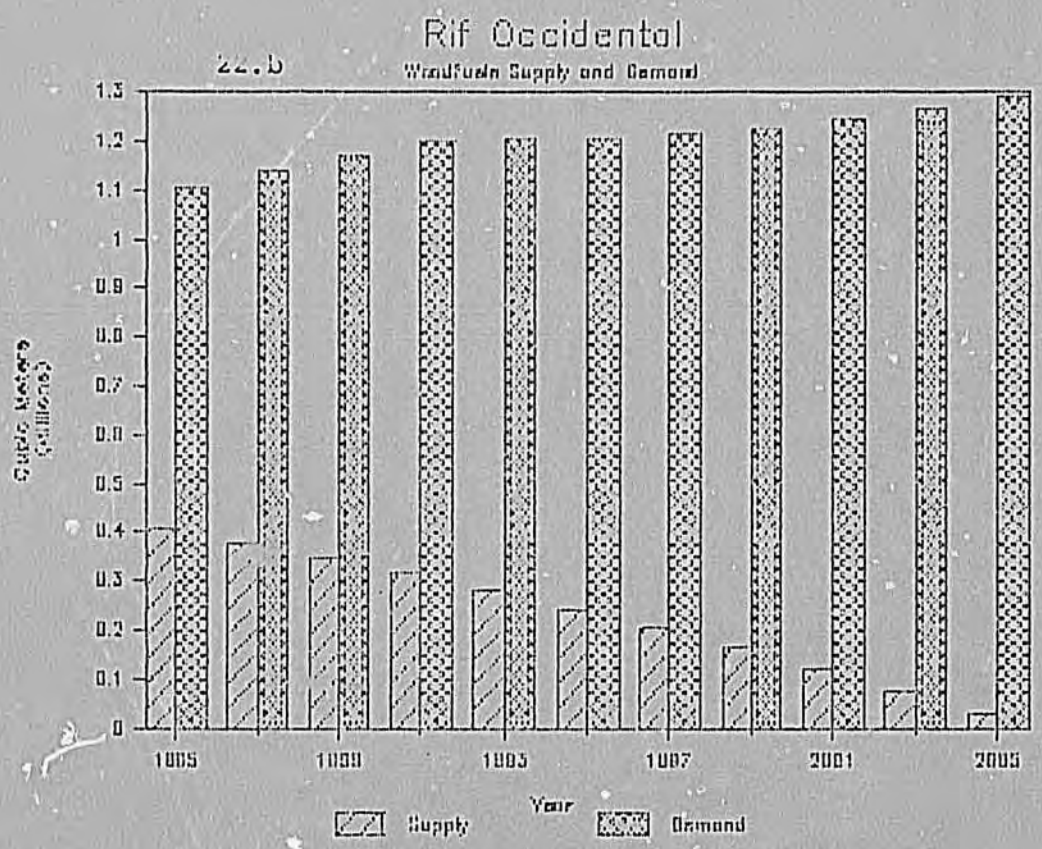
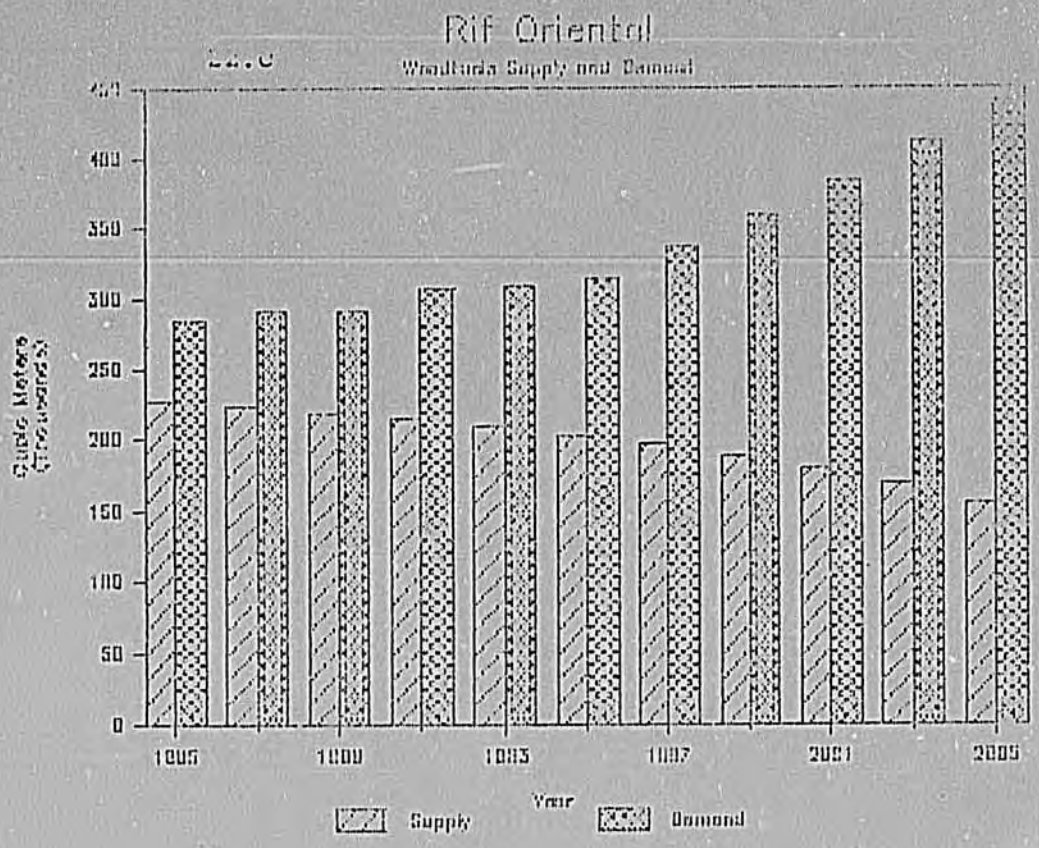
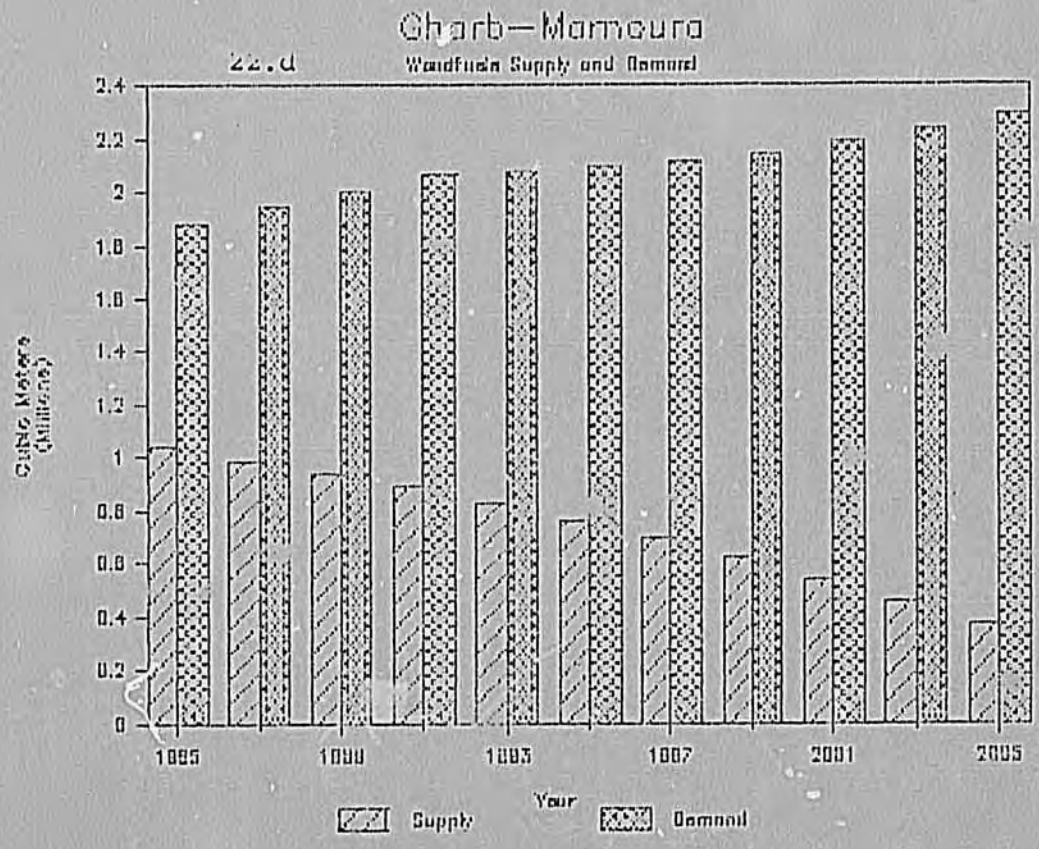

Presaharien...e
21.f
Woodfuels Supply and Demand
Cubic Meters (Thousands)
0
100
200
300
400
500
600
700
800
900
1995
1999
2003
2007
2011
2015
Year
Supply
Demand

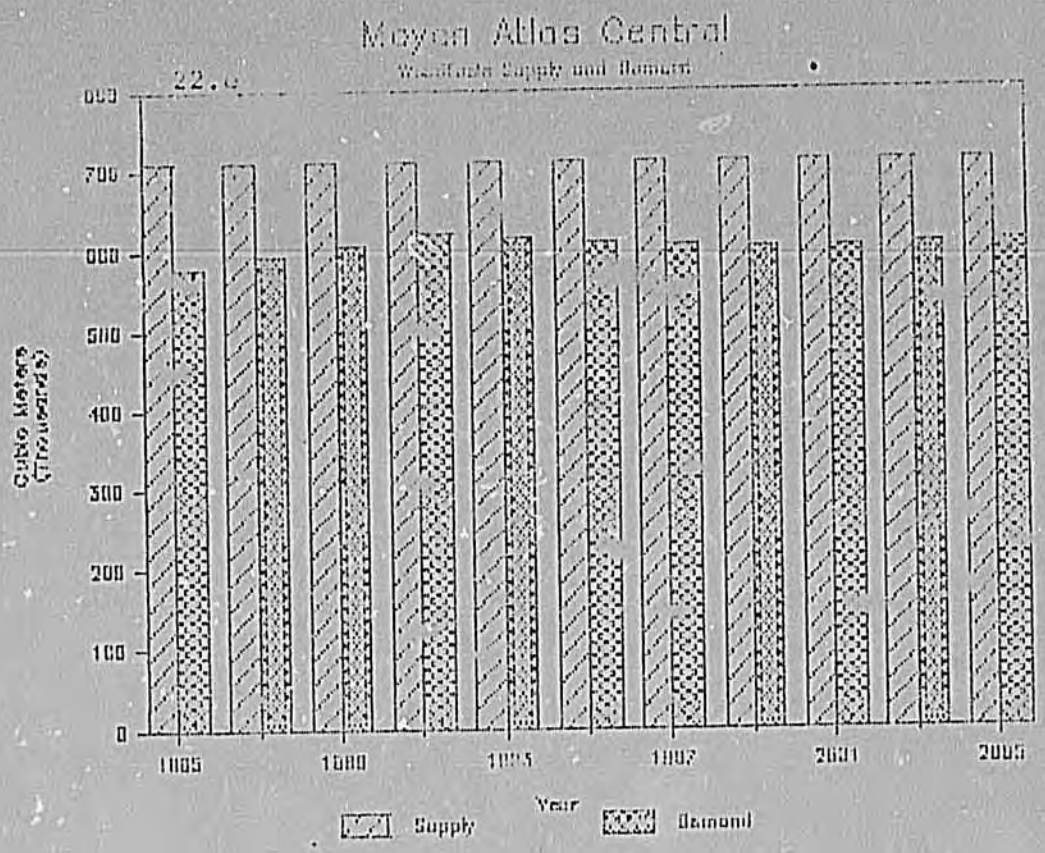
FIGURE 22 - IMPACT OF IMPROVED COOKSTOVES AND NON-WOODFUEL SUBSTITUTION ON FUELWOOD SUPPLY AND DEMAND (FS1)






Rif Oriental
Woodfuels Supply and Demand
Cubic Meters (Thousands)
0
50
100
150
200
250
300
350
400
1995
1999
2003
2007
2001
2005
Year
Supply
Demand


Gharb—Mamoura
22.d
Woodfuels Supply and Demand
Cubic Meters (Millions)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
1995
1999
2003
2007
2001
2005
Year
Supply
Demand


Moyen Atlas Central
22.
Cubic Meters
(Thousands)
0
100
200
300
400
500
600
700
800
1995
1998
2001
2005
Year
Supply
Demand

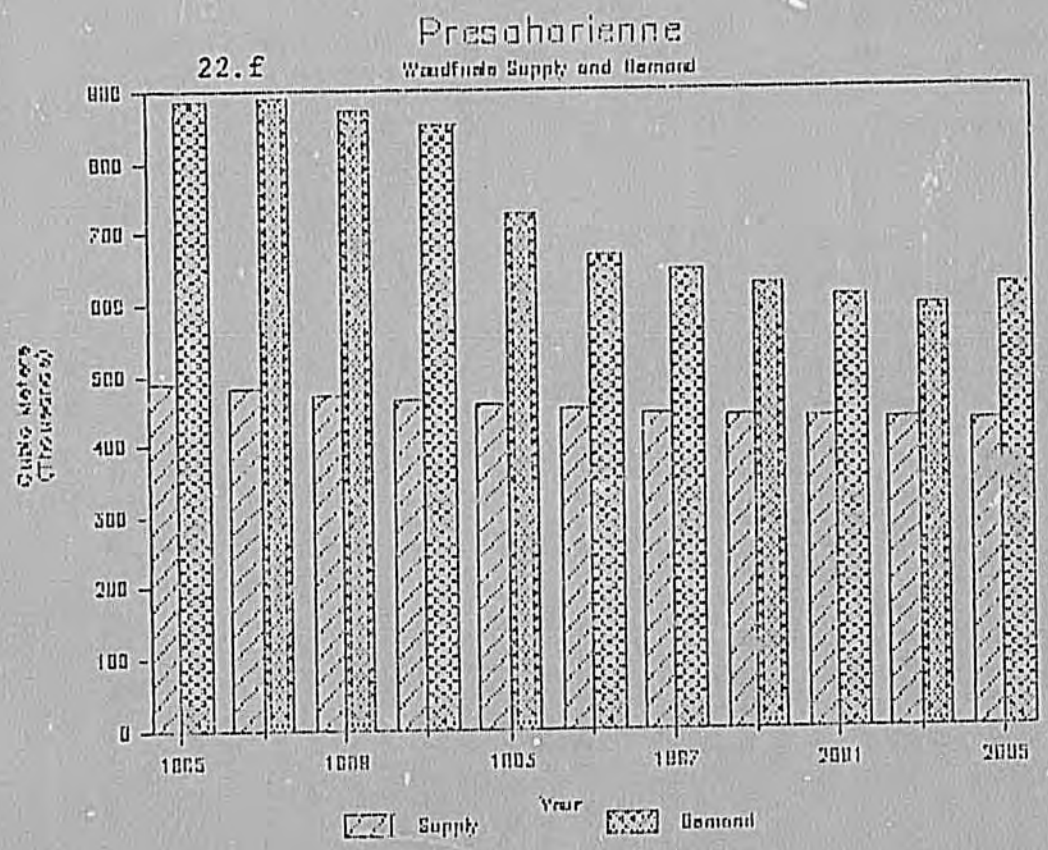

Presaharienne
22.£
Woodfuels Supply and Demand
Cubic Meters
(Thousands)
0
100
200
300
400
500
600
700
800
900
1995
1998
2001
2005
Year
Supply
Demand

FIGURE 23

Rural and Urban Population by Region

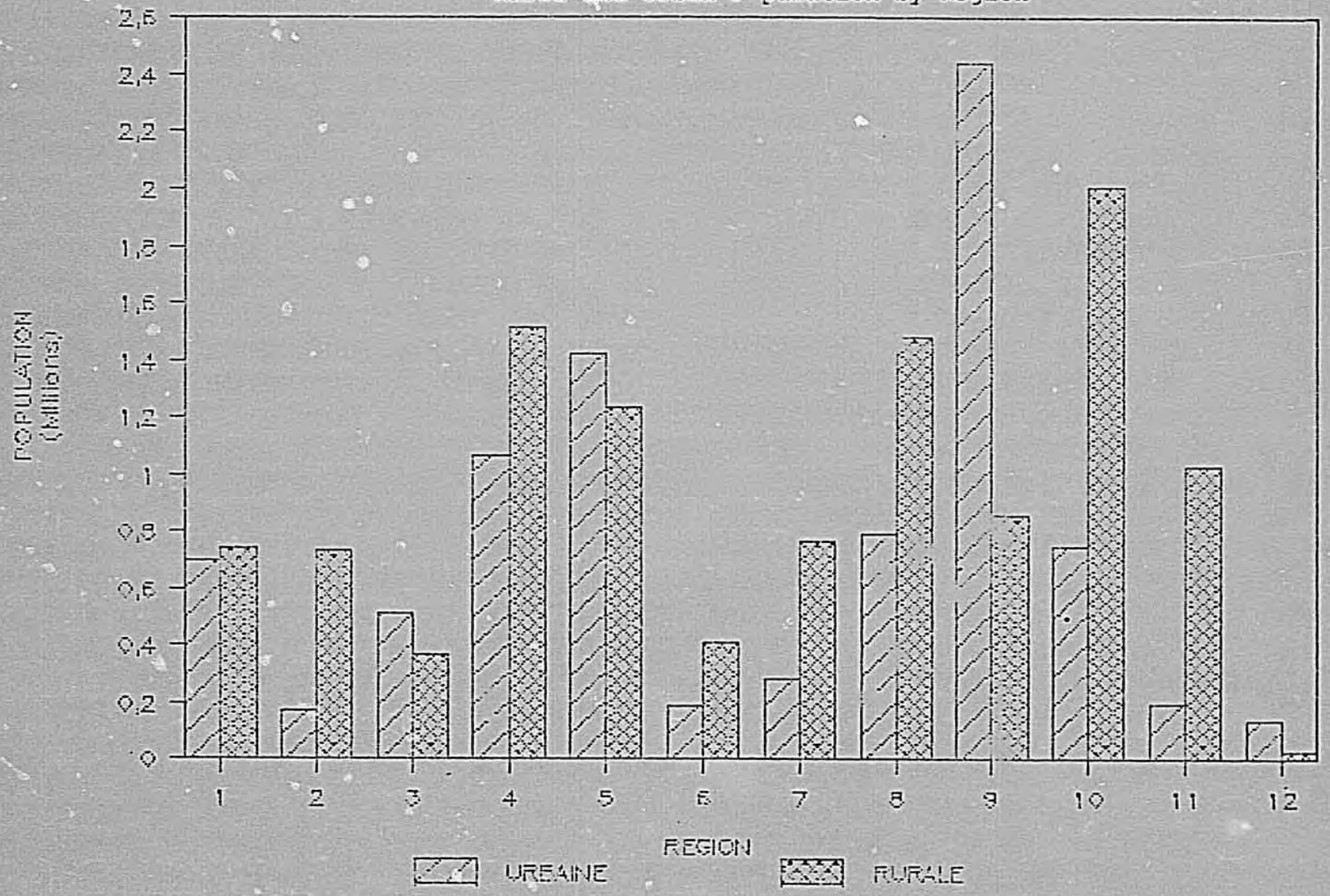


FIGURE 24 - PRESENT POPULATION CONSUMING WOOD AND CHARCOAL

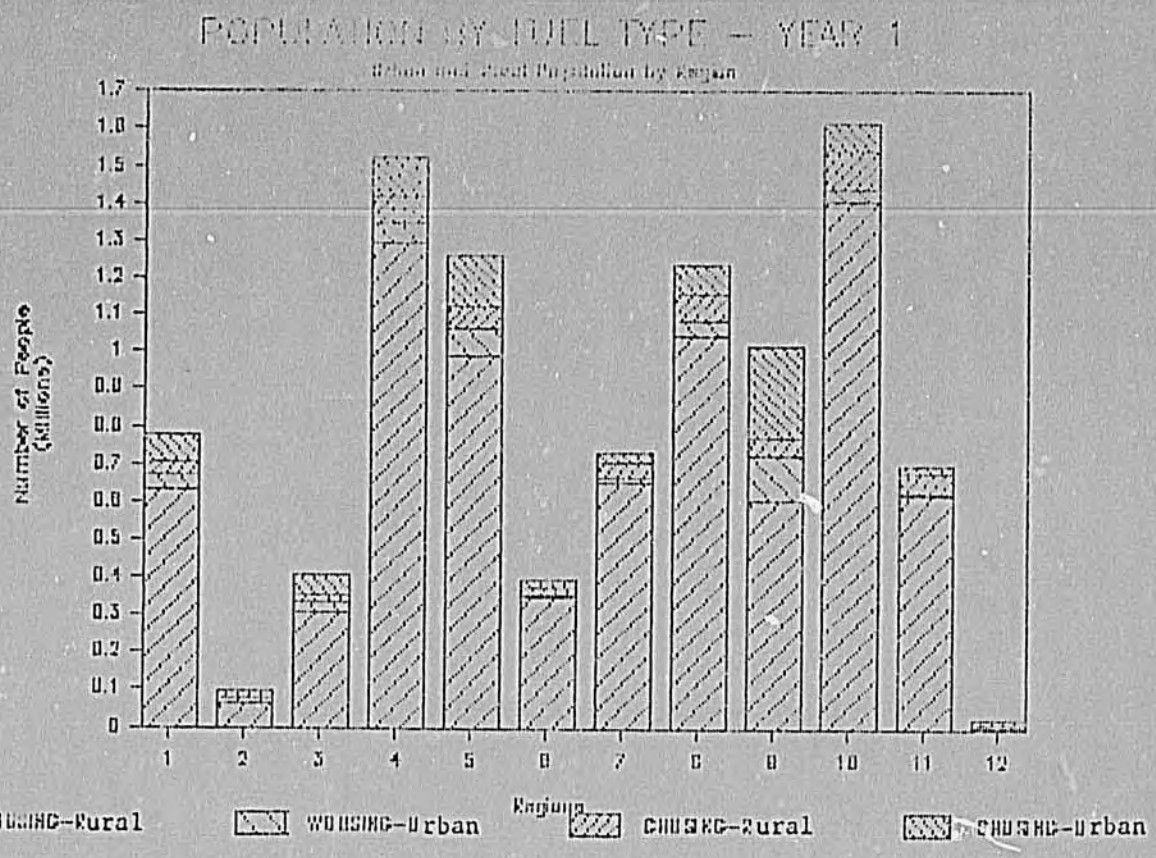


FIGURE 25 - QUANTITIES OF WOOD AND CHARCOAL PRESENTLY CONSUMED FOR ALL PURPOSES

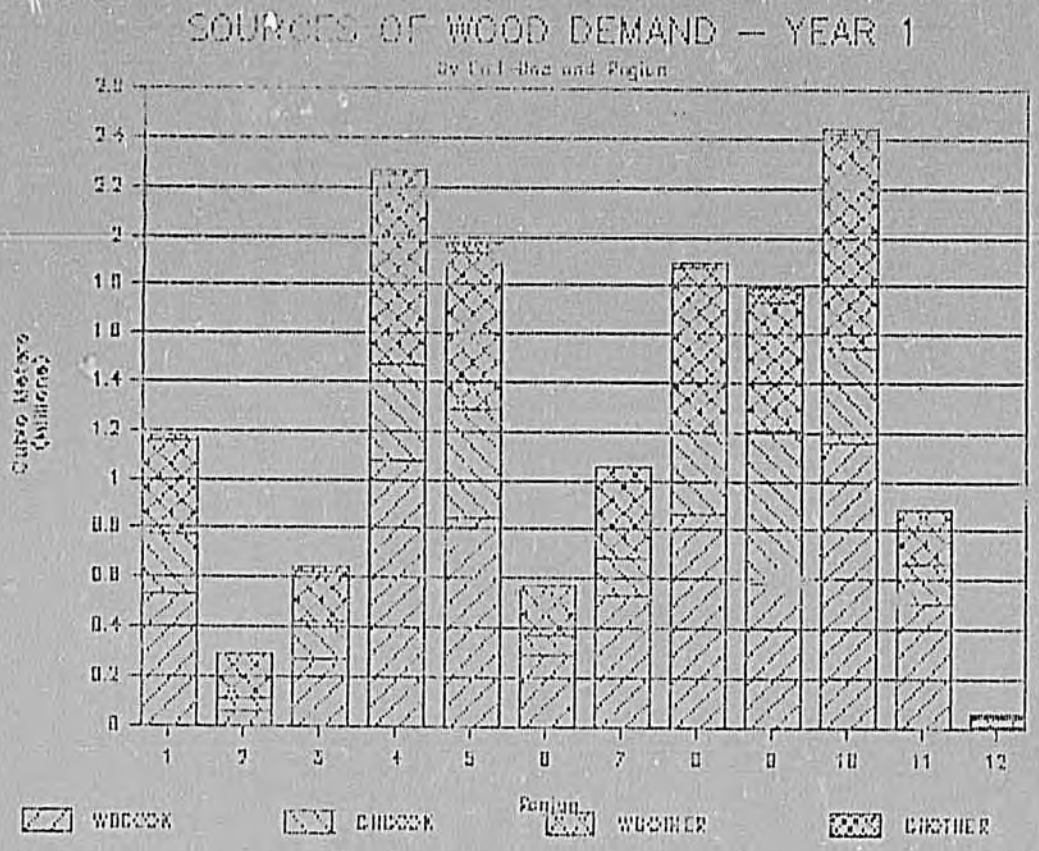


FIGURE 26 - BASE CASE PROJECTION TO YEAR 20 OF TOTAL WOOD AND CHARCOAL DEMAND

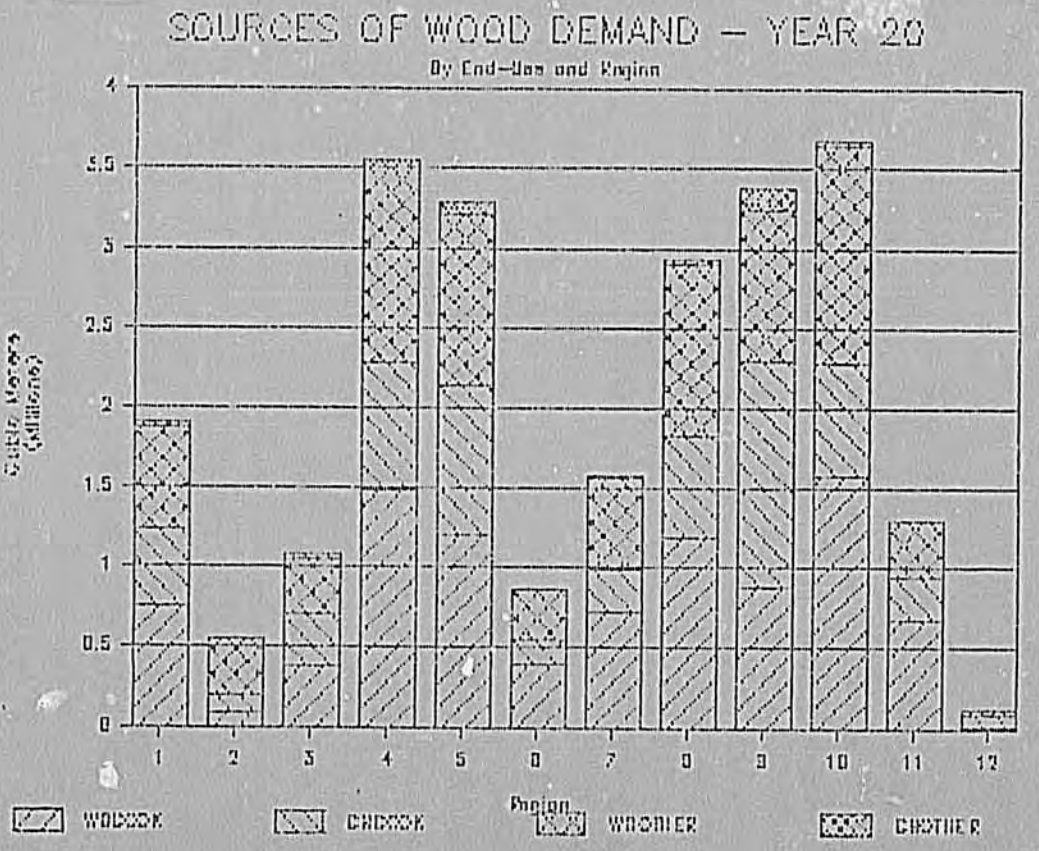
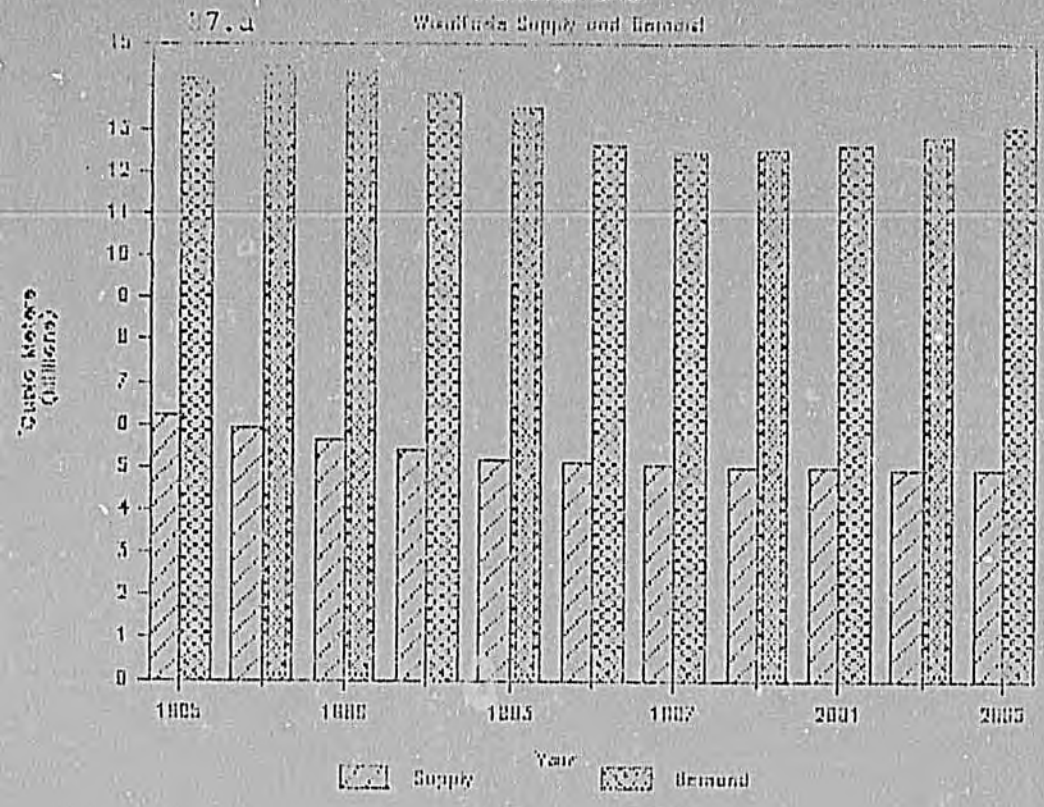
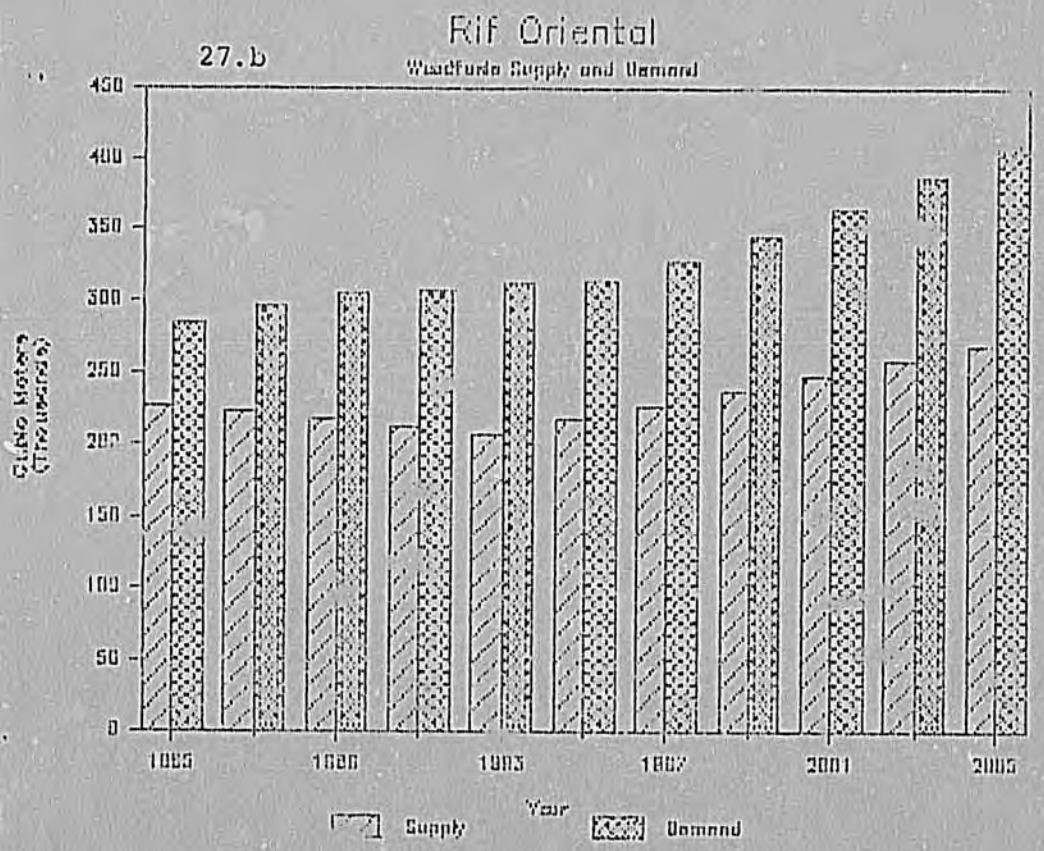
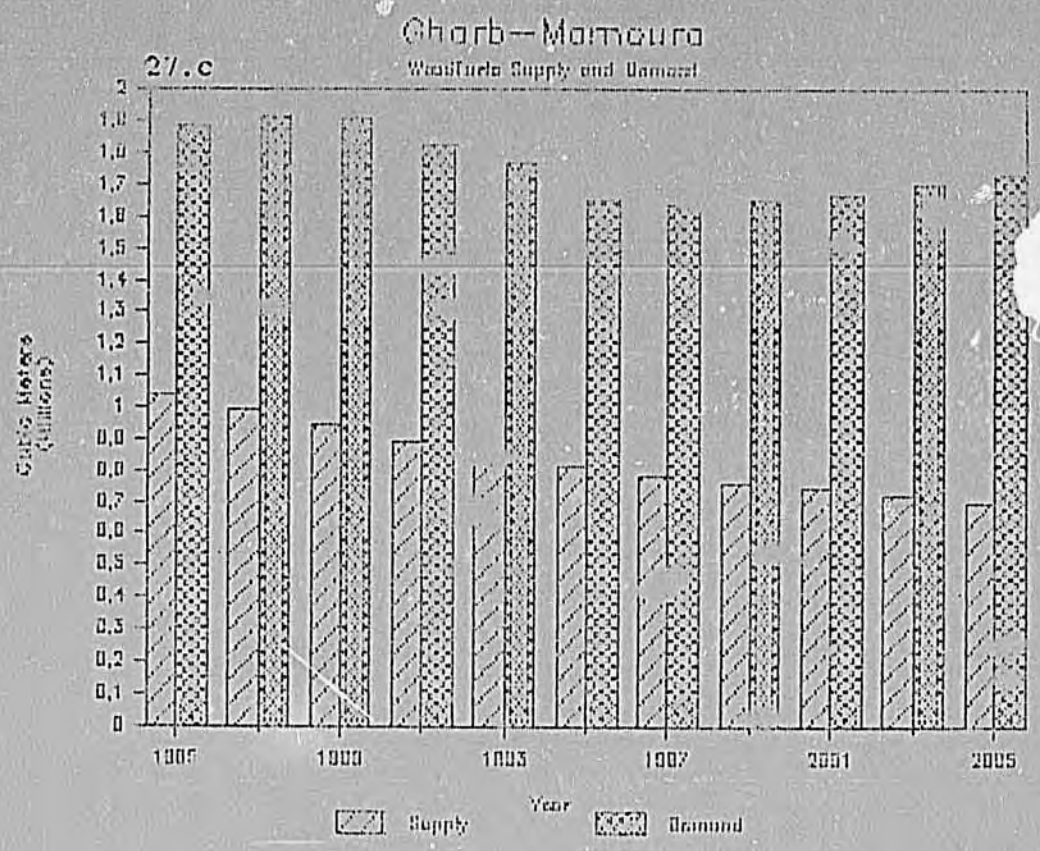
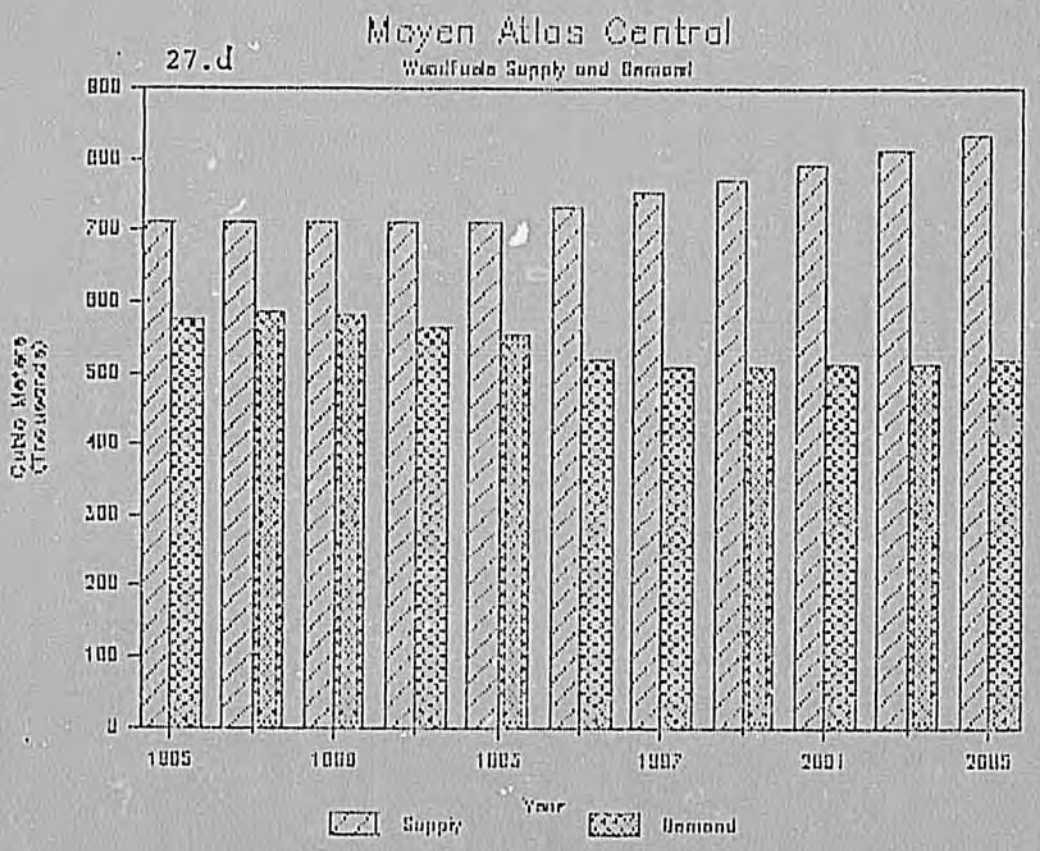


FIGURE 27 - RESULTS OF AN INTEGRATED PROGRAM COMBINING IMPROVED STOVES, WOODFUEL SUBSTITUTION, IMPROVED CHARCOAL KILNS AND BASIC REFORESTATION

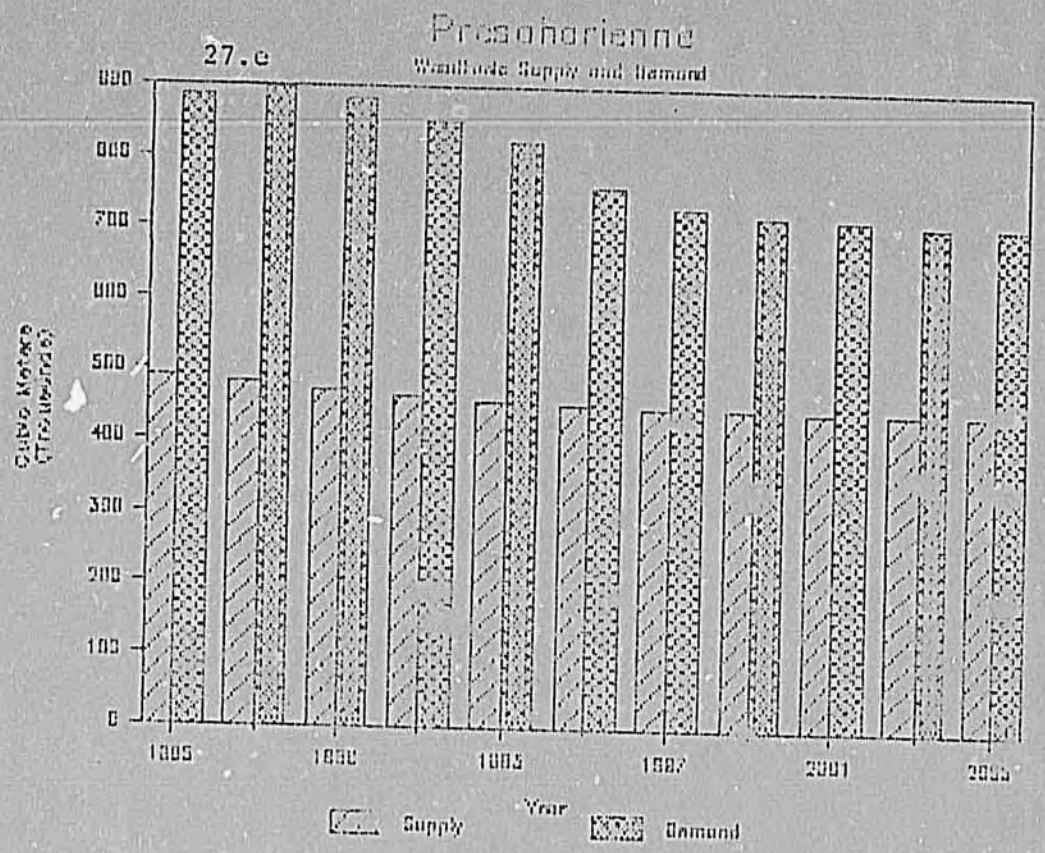





Gharb—Mamoura
27.c
Woodfuels Supply and Demand
Cubic Meters (Millions)
Year
Supply
Demand


Moyen Atlas Central
27.d
Woodfuels Supply and Demand
Cubic Meters (Thousands)
Year
Supply
Demand

27.e


Presahorienne
Woodfuels Supply and Demand
900
800
700
600
500
400
300
200
100
0
1985
1990
1995
1997
2001
2005
Year
Supply
Demand

A P P E N D I C E S

APPENDIX A - REGIONAL DATA BASE USED FOR THIS REPORT

ZONE (REGION, ZONE)	POPULATION URBAINE	POPULATION RURALE	FORET DENSE (HA)	FORET CLAIRE (HA)	FORET TOTALE (HA)	APPAUVRIE/ DEGRADEE (HA)	REBOISEMENT (HA)	VERGERS VILLAGEOIS (HA)	PARCELLES HORS FORET (HA)	STEPPE ALFA (HA)	TERRES NON-FRUITS DE BOIS (HA)	SUPERFICIE FORET TOTAL (HA)	FORET ARBANIE (HA)	ESSENCES SECONDAIRES (HA)	IMPACT INCENDIE	IMPACT PATURAGE	DE-FRICHEMENTS (HA)
1 RIF OCCIDENTAL																	
TANGER	210227	104000	0	0	0	8674	6678	430	54731	0	49700	119500	0	8674	90	8674	4,55
TETOUAN	264726	339480	100	44267	280	159466	22149	8400	272069		137799	602500	0	159466	200	204182	249,78
CHEFCHAOUEN	26499	282005	2782	28994	2175	117727	14959	16000	184169		67284	425000		117727	150	152608	1744,7
SUB-TOTAL	701452	746005	2882	73261	2455	285827	44666	24830	471066	0	254083	1147000	0	285827	540	365425	1999,03
2 RIF ORIENTAL																	
AL HOCEIMA	59493	281818	11811	9342	0	70147	16295	11210		4100	237715	755000		70147	35	90690	1008,32
NADOR	115662	473192	0	4710	100	12674	20855	4200		64700	518162	610000	0	12674	25	17454	27,3
SUB-TOTAL	174553	755001	11811	13752	100	82821	37148	15400	0	68800	755775	965000	0	82821	70	108174	1035,62
3 ORIENTAL																	
FIGUIG	26482	64907	0	0	0	89575	179	900	450146	1000000	0	559000	0	89575	35	89575	107,77
OUJDA	175914	201840	0	146676	121108	7083	29744	23700	910020	633000	162369	2079000	0	7083	500	284867	35,47
SUB-TOTAL	515771	266750	0	146676	121108	96658	29923	24600	5403666	1633000	162369	2639000	0	96658	535	374442	143,24
4 MOYE. BERR.																	
MEKNES	238985	240785	26120	61018	7854	20104	10752	47200	200000	0	30851	399500		20104	35	114896	10,13
FES	548219	257225	3875	57059	21844	26978	19014	24700		700	376210	540000	0	26978	35	169476	173,56
TAZA	138265	595225	14359	165797	60761	75627	15163	29000	251965	155318	722510	1520000	0	75627	310	318044	175,05
TAOUNATE	21177	514799	0	12490	147	23789		71500		0	449274	558000	0	23789	35	36426	0
SUB-TOTAL	1067727	1518032	44354	296364	90206	147418	45210	179300	451965	156018	1598845	3000000	0	147418	415	578842	359,74
5 BHARB-LAOUKA																	
KENITRA	294771	421597	0	68925	0	6057	95149	47306	103590	0	153779	474500	0	6057	150	74932	0
SIDI-KACEM	118715	395414				0					426000	426000				0	0
KHEMISSET	115135	290701	0	142514	50335	102716	49108	12500	121127	0	246830	530000	0	103316	300	296165	7,5
MOLAY BOUSSELHAM	197342	126859	0	20774	838	4076	0	5200	24361	0	64231	127500	0	4076	0	28708	0
SUB-TOTAL	1421163	1234571	0	232213	51173	113469	144157	62300	254078	0	975840	1558500	0	113469	450	399855	7,5
6 MOYEN ATLAS CENTRAL																	
KHENIFRA	101842	222854	49781	236510	9954	40913	9992	2500	767161	144600	375199	1200000	0	40913	35	336758	57,23
IFRANE	44847	55703	15455	27915	0	12945	0	3100	155709	0	75936	321000	0	12945	35	56315	0
BOULEMANE	12495	119977	5991	92750	5090	11530	668	4300	680531	524000	114740	1437510	0	11530	35	115361	11,07
SUB-TOTAL	159182	497539	70227	357175	15144	65388	10660	9900	1603441	668600	565875	3000510	0	65388	105	508434	68,3
7 HAUT ATLAS CENTRAL																	
AZILAL	72759	354776	0	228849	21772	70363	4897	22000	490702	0	166812	1005000	0	70363	35	320599	684,15
BENI-MELLAL	288817	411386	906	114426	6255	26042	1322	21400	27957	0	517395	707500	0	26042	25	140670	57,7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	70	[illegible]	741,85
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Best Available Document

APPENDIX A - (Continued)

ZONE (REGION ADM)	POPULATION URBAINE	POPULATION RURALE	FORET DENSE (HA)	FORET CLAIRE (HA)	FORET TRUVA (HA)	ARBUSTES/ BOIS SECONDAIRE (HA)	PRAIRIE-MENT (HA)	VERGERS VIGNOBLES (HA)	PARCELLES HORS FORET (HA)	STEPPE ALFA (HA)	TERRES NON-PRODUCTIVES (HA	SUPERFICIE FORET TOTAL (HA)	SUPERFICIE FORET AFFECTEE (HA)	ESSENCES SECONDAIRES (HA)	IMPACT RESIDENTIEL	IMPACT PATURAGE	DE-FRICHEMENTS (HA)
SUB-TOTAL	795,187	1485,03	0	190993	37924	219014	13440	119710	122224,5	0	1035393	2307500	11000	208904	10	451721	2,55
7 CHAOUIA																	
SETFAT	140956	548400	0	3081	2134	7979	11263	4500	83993	0	857345	975000	0	7979	5	15174	0
BEN SLIMANE	74260	149000	0	22656	10291	18943	12186	11500		0	2366,4	275000	0	18943	123	51750	0
AI SEBAELA IA	2155719	104497	0	0	0	0	0	700		0	144300	145000	0	0	0	0	0
MEHAOUAIA	108120	48705				0					16500	16500			0	0	0
SUB-TOTAL	2441687	851300	0	25737	12425	26922	23449	16700	83993	0	1218469	1412500	0	26922	125	64924	0
10 SECTEUR ATLANTIQUE																	
EL JADIDA	150007	617714	0	0	0	0	23272	23203	62953	0	490500	600000	0	0	0	0	0
SAFI	267162	479426	0	0	0	8756	9010	5100	10014	0	695540	718500	2896	4590	5	8756	170,97
ESSAOUIRA	49858	746825	0	6431	97821	171693	11496	22530	6789	0	316500	633500	137236	34767	35	275815	0
AGADIR	245860	503551	0	64676	101951	541199	8442	31000	1212772	0	256700	2237000	525450	15749	200	797735	0
TIZNIT	40850	272490	0	0	3900	122458	1416	1500	442334	0	114492	696000	102450	8	20	17625	0
SUB-TOTAL	753857	2618986	0	71067	203552	854146	53736	83330	1734863	0	1873232	4885000	799032	55914	260	1103895	170,97
11 PREAHARIENNE																	
ERRACHIDIA	64731	356476	0	4115	0	37640	0	15100	5836245	12000	53400	5933500	0	37610	10	41755	0
CHARIFIENNE	48914	434978	0	26824	13440	173078	554	25000	3825132	38015	52907	4155000	8700	164578	35	213342	0
TATA	3142	96808	0	0	3420	49000	16	3000	2528380	0	3194	2592500	0	49000	20	52420	0
ELELMIM	42886	85790	0	0	4663	3100	1177	600	2836155	0	29300	2875000	3100	0	5	7768	0
TANTAN	41431	5559	0	0	0	0	0	0	1729510	0	0	1729500	0	0		0	0
SUB-TOTAL	201104	1003641	0	30939	21523	262818	1747	43700	16783962	50015	140791	17310500	11900	251018	70	315285	0
12 SAHARIENNE																	
ESSEMARA	17755	2727	0			0	0	0	0	0	6176000	6176000			0	0	0
LAAYOUNE	96784	16627	0	0	0	0	16	0	0	0	3938954	3938000	0	0	0	0	0
BOUJDOUR	2397	4834	0	0	0	0	0	0	0	0	10012000	10012000	0	0	0	0	0
DLEB EDDAHAB	17822	3674	0	0	0	0	0	0	0	0	5088000	5088000			0	0	0
SUB-TOTAL	135758	27912	0	0	0	0	16	0	0	0	25211954	25212000	0	0	0	0	0
TOTAL	3679420	11181634	172010	1783482	593153	2281481	414961	619000	25194034	2581423	24518236	71095000	821832	1429649	2450	4760176	4528,1
REFERENCES	3	3	1,5	1,5	1,5	1,5	3	4	2	1,5	[illegible]	3	1,5	1,5	1		1

REFERENCES

1. [illegible] Forêts, 1976, [illegible]
2. [illegible] Forêts, 1976, [illegible]
3. [illegible] Forêts, 1974, [illegible]
4. [illegible] Forêts, [illegible]
5. [illegible] Forêts.
6. [illegible] 1975

Best Available Document

Appendix B

DOCUMENTS CONSULTED

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The fuelwood supply and demand data, and the investment information required by the FRAP model, were extracted from the following documents:

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