Liquid Biofuels

(Ester-Oils)

Project Title	Needs and Objectives
Modelling nitrogen fertilisation 1999	The principal motivation for developing biofuels (bioethanol and biodiesel) is the potential environmental benefit derived from using biofuels instead of petrochemical fuels. Nevertheless, growing the agricultural raw materials used to produce biofuels (wheat, beet, rapeseed or sunflower) can create pollution due to the poorly managed use of nitrogen, and specifically nitrates. It is therefore important to improve the management of energy crop fertilisation in order to optimise their environmental benefit. Better fertilisation management will also have a positive impact on cost price by increasing productivity and limiting the use of fertilisers. The objective of this project is to analyse and model the impact of different agricultural techniques on energy and environmental performance by studying the use of nitrogen fertilisers on wheat-rapeseed crop rotations. The first stage will consist in crop experimentation and formalisation. The second stage will be devoted to modelling and testing the models.

Project Title	Needs and Objectives
Impact of vegetable oil methyl esters (VoME) on the performance of direct-injection "Common Rail" diesel automotive engines 1999	Incorporating vegetable oil methyl esters (rapeseed and sunflower) into diesel fuel is very common today. In fact, these esters are currently added at the refinery, before the fuel reaches the distribution network and arrives at the pump. Since the first technical validations of VoME blending were conducted, a new family of engines, the "Common Rail" engines, has been developed. Almost no technical data exist on how these esters impact the performance of Common Rail engines. The goal of this project is to carry out an in-depth study of the performance of high-pressure direct-injection "Common Rail" diesel automotive engines fuelled by VoME-based blends. The first phase will comprise engine trials (choice of test fuels, bench-scale tests and tests on vehicles). The second stage will examine the thermal stability of the blends (heat shock simulation). The third stage will concentrate on compatibility of fuels and specific materials (choice of materials, ageing tests, characterisation of materials). The fourth stage will be devoted to interpreting the study's results.

Project Title	Needs and Objectives
Optimising rapeseed cost-effectiveness: using urban wastewater sludge to fertilise rapeseed 1997	The principal non-food market outlet for rapeseed is the production of rapeseed methyl ester (RME), a biofuel used as a partial substitute for diesel fuel in motors. The cost price of RME is currently higher than that of petrochemical fuels. One way to reduce the cost of RME is to limit the use of expensive fertilisers in growing rapeseed. Residual urban sludge could be used to fertilise these crops. The aim of this project is to test the effects of using residual urban sludge to fertilise an energy rapeseed technical pathway followed by a wheat pathway. The first stage will be devoted to confirming the agronomic benefit of using residual urban sludge on industrial rapeseed. The second stage will verify the real impact on rapeseed production costs and on the energy performance of the processing chain. The third stage will aim to verify the innocuousness of residual sludge for the RME processing chain (presscake and oil). The final stage will verify the innocuousness of residual sludge in terms of land capital for future crop production.

Project Title	Needs and Objectives
Environmental impact of urban use of biofuels 1997	The principal motivation for developing biofuels such as biodiesel (rapeseed methyl ester) or ETBE (a bioethanol-derived additive in unleaded gasoline) is their potentially positive impact on the environment. Until now, only the overall impact of biofuels on the environment has been studied, by conducting an environmental audit. It would be useful to study the local impact of using of these fuels, in particular their impact on air quality in cities. The goal of this project is to assess the impact on air quality of adding ETBE or its synthetic equivalent, MTBE, to gasoline, and of using rapeseed methyl esters in diesel fuel. The first stage will centre on both a bibliographic study and the gathering of data on reformulated fuel emissions. The second stage will be devoted to modelling these emissions for the Strasbourg-Kehl region. The third stage will consist in adapting the homogeneous chemistry of the model. In the fourth stage, a model will be developed (based on the EZM and MARS models). Finally, the fifth stage will concentrate on impact studies designed specifically to measure the effect of reformulated fuels on air quality.

Liquid Biofuels

(Ester-Oils)

Project Title	Needs and Objectives
Improving rapeseed's genetic resistance to phoma: an insurance policy for biofuel production 1997	Biodiesel is derived from rapeseed and used in diesel fuel blends for motors. Compared with petrochemical fuels, biodiesel is not currently cost-competitive. One way to increase cost-competitiveness is to improve yield at the stage of agricultural production. Today, one of the main causes of decline in yields is phoma attack on crops. It would be very useful to study genetic resistance to phoma in order to improve yield and limit the use of pesticides. The goal of this project is to develop a lasting method for fighting phoma genetically. The first stage will be devoted to characterising the resistances found in Doublol, Maxol, Capitol and Darmor. This will entail genetic mapping to localise the detected phoma-resistant genes, corresponding to avirulence genes. The second stage will be devoted to evaluating the extent of effectiveness and durability of the resistances. The third stage will concern resistance management.

Project Title	Needs and Objectives
Impact of blending vegetable oil esters on non-regulated diesel motor emissions 1997	Vegetable oil methyl esters (VoME) can be used in a blend with diesel fuel for buses and trucks, as well as for cars equipped with a diesel engine. At the present time, data on pollutant emissions generated by diesel fuel/VoME blends are disparate and do not present a clear picture of their impact on air pollution, specifically in cities. For this reason, it is necessary to assess the effect of using VoME blends on vehicle emissions. The aim of this study is to determine how emissions of regulated and non-regulated pollutants are impacted by rapeseed and sunflower methyl ester blends. The first stage will attempt to measure the precise effect of blending vegetable oil esters (5, 10 and 30%) on emissions of specific pollutants, such as aldehydes, soluble particle fractions and individual hydrocarbons. The second stage will concentrate on evaluating the effect of these blends on factors taken into account for assessing air quality. The third stage will study the interaction of VoME blends and nitrogen oxide emissions in order to make recommendations, if necessary, for taking action to monitor them. The tests will be conducted on a dynamometric chassis and on test bench motors.

Project Title	Needs and Objectives
Use of 20% sunflower ester blends in captive fleets 1997	Methyl esters of rapeseed (RME) and sunflower (SME) can find outlets as components of diesel vehicle fuel to supply captive fleets (buses, trucks and farm tractors). It should be confirmed, on a practical level, that esters, specifically sunflower esters, are appropriate for such uses. It would also be useful to test different blend proportions in diesel, and specifically high ester proportions. The goal of this project is to test high proportions of vegetable-oil methyl esters in fuel for captive fleets. The first phase will be conducted by the Champagne Cereals Company, and will test fuel containing 50% RME for distances of more than 250,000 km. The second stage will comprise testing 5 to 30% SME in tractors for one year. The third stage will involve the participation of the Paloise Transport Authority, and will include tests on 30% SME for two years. A very strict inspection and maintenance procedure has been established (oil analysis, opacity check, filter and fuel injector check).

Project Title	Needs and Objectives
New technical pathways for energy-use rapeseed 1996	The reduced environmental impact of using biofuels instead of petroleum-based fuels is seen as the main advantage of developing biofuels such as biodiesel (rapeseed methyl ester). One of the factors that could improve a crop's environmental performance is modification of the sowing date, which could make it possible to limit nitrate pollution. It would be useful to test early sowing dates in order to measure the impact of such a change on the technical, economic and environmental aspects of biodiesel production. The goal of this project is to analyse the environmental benefit of bringing forward the usual sowing date of rapeseed by one month. The first stage will consist in determining the advantages and the limitations of an early sowing date for energy rapeseed. The second stage will concentrate on evaluating the energy, economic and environmental performance of technical pathways for energy rapeseed which integrate an early sowing date.

Liquid Biofuels

(Ester-Oils)

Project Title	Needs and Objectives
Evaluation of deposition processes in vegetable oil combustion 1995	Rapeseed oil could be used as a fuel for energy production, particularly in building boiler plants. Nevertheless, not enough is known about the behaviour of rapeseed oil as opposed to diesel fuel, which is an impediment to its wider use, especially as it is thought to lead to the formation of deposits that foul the boiler. Study of the fundamental characteristics of rapeseed oil combustion is needed, with particular attention to deposit formation. The goal of this project is to study and model the physical and chemical mechanisms involved in deposit formation during the combustion of pure vegetable oils, for their utilisation with fuel oil or diesel fuel. Filtered, degummed rapeseed oil will be used. The first stage will address the chemical aspects, and will seek to understand the reaction pathway leading to deposit formation. The second stage will look at the physics, and seek to understand the mechanisms of vaporisation and gasification of rapeseed oil droplets as a function of air pressure and temperature. The third stage will be devoted to comparing the fog spray structures of rapeseed oil and diesel fuel.

Project Title	Needs and Objectives
Rapeseed production in environmentally acceptable conditions 1994	Biodiesel is a biofuel produced from rapeseed which can be used as a substitute for diesel fuel in vehicles. The agricultural production of rapeseed constitutes a full-fledged step in biodiesel production. An environmental audit needs to be conducted to characterise the environmental impact of growing rapeseed in order to validate the overall impact of biofuels. It is particularly necessary to characterise N2O emissions, as environmentalists have claimed that rapeseed cultivation results in an increase in N2O levels. The aim of this project is to determine the environmental impacts of rapeseed cultivation for biofuel production. This project should also help to develop better-adapted agricultural techniques. The first stage will be devoted to quantifying the fluxes and stocks of all forms of carbon and nitrogen during one rapeseed crop and filler plant cycle. In the second stage, a model of carbon and nitrogen fluxes and stocks will be developed to serve as the technical basis for an environmental audit. The goal of the third stage will aim to make proposals for adapting agricultural techniques, and evaluate their feasibility and cost-effectiveness.

Project Title	Needs and Objectives
Genetic improvement of rapeseed 1994	Rapeseed is one of the major crops used to produce non-food agricultural commodities and specifically biodiesel, a partial substitute for diesel fuel used in motors. The cost price of non-food agricultural commodities derived from rapeseed is often higher than that of synthetic products. One way of reducing this cost is to increase crop yield. No hybrid varieties of rapeseed exist today, even though hybrids are known to increase yield. The goal of this study is to undertake genetic selection of hybrid varieties of rapeseed for food or industrial use. The first stage will be devoted to the selection of sterile male and restorative lines. Experimental hybrid seeds will be produced in the second stage. The third stage will centre on hybrid experimentation in multi-site trials. The fourth stage will be devoted to preliminary multiplication of the hybrids and the selected descendants. The fifth stage will be a study of the composite hybrid descendants grown in isolated plots. In the sixth stage, double-zero restorative populations will be selected. Finally, the last stage will be devoted to checking varietal purity.

Project Title	Needs and Objectives
Using oil for energy 1994	Rapeseed oil could have a non-food use as a substitute for fuel oil in boilers, especially in those used on farms for indirect drying of grain. In order to validate this market outlet, it is necessary to know more about rapeseed oil combustion in burners, especially with regard to technical and economic feasibility and environmental impact. The aim of this project is to develop the utilisation of vegetable fuel oil in burners. The first stage will be devoted to preliminary laboratory tests on the burner to determine whether it is necessary to operate it with an exchanger (significant economic impact on the project). In the second stage, the experimental burner will be installed on a farm, in order to test the laboratory results in a real-life situation. The third stage will be devoted to an economic and marketing study.

Liquid Biofuels

(Ester-Oils)

Project Title	Needs and Objectives
Fuel oil 1994	Rapeseed oil could find non-food market outlets as a substitute for home heating oil in building boiler plants. The home heating oil used in building boilers, however, must comply with administrative, customs and building management specifications. Rapeseed oil, which is by nature very different from home heating oil, does not meet these specifications, and thus it cannot be used today. A rapeseed-oil based fuel which would comply with specifications has to be formulated. The aim of this project is to develop a rapeseed-oil based fuel which meets specifications and to test it in a building boiler plant. The first stage will include identifying the available refinery oil blends which would make it possible to bring rapeseed oil's physical and chemical properties into the range of a home heating oil, determining simple rules for its formulation, and maximising the level of rapeseed oil incorporation. The second stage will be devoted to a combustion demonstration in an existing boiler, at the Roncherolles School (in Bolbec, Seine Maritime department), using at least one of the best rapeseed-based fuels.

Project Title	Needs and Objectives
5% ester formulation in diesel fuel 1994	Biodiesel (rapeseed methyl esters) can be used as a biofuel additive in diesel fuel. This approach is particularly appropriate for bus fleets because their diesel fuel supply is localised and therefore alternate fuels can easily be substituted. In 1994, however, the technical questions regarding the incorporation of biodiesel into diesel fuel have not all been answered, and they constitute a considerable impediment to wider use of this biofuel. More needs to be known about fuel formulations which include rapeseed methyl esters, and the impact of using these fuels in bus engines must be assessed. The objective of this project is to study the ageing of diesel motors fuelled by a 5% rapeseed methyl ester blend (RME5) and to examine the behaviour of RME5 blends. It is expected that this study will provide additional information indispensable to all the industries involved. The first phase will centre on a study of intake valve fouling. The second stage will be devoted to studying the cold-weather behaviour of the blends. The third stage will examine their behaviour in the presence of water. The tests will be carried out in the laboratory, on test bench motors, and in bus fleets.

Liquid biofuels

(Ethanol–Ether)

Project Title	Needs and Objectives
Rheological behaviour of maize albumen 1999	In a previous programme a new dry-process fractionation method for wheat was studied, with a view to improving the purity of the fractions (protein and starch) obtained and to lowering costs. It would be interesting to test the same technology on maize, to extract greater value by separating starch/protein macromolecules. The aim of this project is to study the structural basis for "fractionability" of maize via a dry process, drawing upon the results acquired for wheat. The first phase will be devoted to measurement of rheological properties for batches of maize grain. The second phase will focus on identifying the influence of such factors as the hardness and glassiness of the grains on their mechanical properties and their susceptibility to fractionation. The third phase will be a study of the impact of other factors related to the feedstocks and processes. The fourth phase will investigate appropriate pre-treatment steps designed to facilitate fragmentation of the albumen and separation of the constituent elements.

Project Title	Needs and Objectives
Study of varying proportions of ethanol and premium gasoline in a flexible-fuel vehicle 1998	Bioethanol obtained from wheat or beets is chemically transformed into ETBE and then blended as an oxygenate into unleaded gasoline. Bioethanol can also be used, without being converted, as a fuel and as an oxygenate in unleaded gasoline blends. This use for bioethanol is particularly interesting since legislation requires the blending of a significant proportion of oxygenates in all fuels, in the medium term. Bioethanol can meet this need for oxygenates, but at present there is a lack of information concerning the technical feasibility and the environmental impact of such an approach. The aim of this project is to study a "flexible" vehicle, which can use a fuel made up of different proportions of ethanol and gasoline, in order to evaluate its performance and the emissions it produces. The first stage will concentrate on the test engine. The fuels to be used will be the subject of study in the second stage. The third stage will include testing and measurement. The fourth stage will centre on a comparative study of the different fuel blends.

Project Title	Needs and Objectives
Pentose fermentation by a recombinant strain of Zymomonas mobilis 1998	At present, bioethanol obtained from beet or wheat fermentation is used principally as an additive for unleaded gasoline, after it has been chemically transformed into ETBE. The cost price of bioethanol is higher than that of fossil fuels. One way to reduce its cost is to optimise the fermentation process. In the process currently used, only the fermentable sugars are transformed into ethanol. Specifically, the C5 sugars contained in the cellulosic fraction do not undergo conversion. It would be useful to study a way of rendering these C5 sugars fermentable. The goal of this project is to evaluate the possibilities of producing ethanol by inducing fermentation of the C5 sugars derived from lignocellulose (xylose and arabinose) with a recombinant strain of Zymomonas mobilis. In the first stage, recombinant strains of Z. mobilis will be studied by conducting growth ethanol production tests in media containing glucose, xylose and arabinose. The second stage will concentrate on developing new strains. In this way, the performance of the available recombinant strains will be improved by developing new strains and by optimising the fermentation process.

Project Title	Needs and Objectives
Obtaining fuel ethanol from the cellulosic fraction of grain straw 1998	At present, bioethanol obtained from beet or wheat fermentation is used principally as an additive for unleaded gasoline, after it has been chemically transformed into ETBE. The cost price of bioethanol is higher than that of fossil fuels. One way to reduce its cost is to optimise the fermentation process. In the process currently used, only the fermentable sugars are transformed into ethanol. Specifically, the C5 sugars contained in the cellulosic fraction do not undergo conversion. It would be useful to study a way of rendering these C5 sugars fermentable. The objective of this project is to obtain ethanol for use as fuel from the cellulosic fraction of grain straw material. The first stage will consist in developing a pretreatment process based on cooking in the presence of diluted acid. The second stage will be devoted to constructing Trichoderma reesei strains that produce enriched cellulosic activity: endo-glucanase activity and hydrolysis of hemicellulosic or phenolic residues that block cellulase action. The third stage will centre on developing a process utilising the improved enzymatic complex in association with a strain of yeast which ferments at 40°C.

Liquid biofuels

(Ethanol–Ether)

Project Title	Needs and Objectives
Estimation of nitrate and pesticide losses in areas of large-scale crop cultivation 1997	The principal motivation for developing biofuel substitutes for petrochemical fuels is their more positive impact on the environment. Agricultural techniques are not, however, without environmental impact; nitrates and pesticides used in agricultural production pollute groundwater as well as surface water. Developing alternative agricultural techniques in order to improve the environmental performance of biofuels is now an urgent matter. The goal of this project is to quantify the effect, on the watershed scale, of different agricultural schemes on loss of water, nitrogen and pesticides into groundwater. The first stage will concentrate on measuring the effect of different technical pathways on water and nitrate loss. The second stage will focus on evaluating plot-scale "nitrogen" and "pesticides" transfer and conversion models, using additional measurements. The third stage will simulate, on the watershed scale, the impact of alternative techniques on the quality of percolating waters. This type of simulation can be extended to other regions with similar soil characteristics.

Project Title	Needs and Objectives
Blending alcohol in diesel fuel: a study of the effects on fuel composition, engine performance, gaseous and particulate pollutant emissions and energetic characteristics 1997	Bioethanol is a fuel obtained from wheat or beets and is currently used to synthesise ETBE, an additive for unleaded gasoline. It could also be used in the formulation of a fuel for diesel motors made up of non-modified bioethanol and diesel fuel. It has already been shown that blending ethanol has a positive impact on particulate emissions. Many questions concerning the technical feasibility of adding ethanol to diesel fuel remain unanswered, however, and further study is needed, therefore, to explore the issues of stability, explosiveness and impact on other pollutants. The objective of this study is to evaluate the effects of blending ethanol in diesel fuel. The first stage will determine the conditions in which an alcohol-diesel blend can meet the current specifications for diesel fuels. In the second stage, vehicle trials will be conducted to show the potential advantages of blending agriculturally-derived alcohol in fuel for diesel engines. The study criteria will be: emissions of regulated pollutants; aldehyde and aromatic fractions in unburnt hydrocarbons; energy produced, and maintaining good engine performance.

Project Title	Needs and Objectives
Designing technical paths for obtaining ethanol from wheat 1995	Bioethanol, which is produced in part from wheat, is chemically modified to synthesise ETBE, an oxygenate compound used as an additive in the formulation of unleaded gasoline. At present, bioethanol obtained from wheat is not competitive with "traditional" fuels such as gasoline. One way to increase its competitiveness is to optimise wheat crop yield. Solving such a complex problem is not simple, but developing a computer model could produce results. Thus, it would be useful to test this approach by the modelling of one region. The goal of this project is to identify one or several technical pathways which meet the goals set for wheat-derived ethanol more satisfactorily than the currently existing pathways for food-use wheat. The first stage will focus on describing the wheat ethanol processing chain, in terms of general biofuel issues and management of ethanol wheat fluxes. The second stage will develop a decision-making tool that will aid in identifying the technical pathways which meet a given set of specifications. The third stage will centre on evaluating the pertinence of the choices proposed by the decision-making tool.

Project Title	Needs and Objectives
Improving the productivity of bioconversion of wheat into ethanol 1995	Bioethanol is a compound that can be derived from wheat. It is chemically converted into ETBE, which is an additive used in the formulation of unleaded gasoline. At present, the cost price of bioethanol is higher than that of gasoline. One way to reduce its cost is to improve yield in alcohol production from wheat. At present, fermentation transforms only the starch into ethanol, and not the wheat bran, which is a coproduct of the process. Natural enzymes exist, however, that can convert wheat bran into sugar and then into ethanol. It would be useful to determine if introducing enzymes during the process could convert bran to ethanol. The objective of this project is to identify the enzymes which give maximum fermentable sugar production as well as optimal fermentation conditions. The first stage will concentrate on studying the utilisation of bran. In the second stage, the wheat mash will be studied. The third stage will also centre on the study of wheat bran and mash, but this time hydrolysis will be preceded by a pretreatment process. The last stage will be devoted to gathering the data necessary for a technical and economic study.

Liquid biofuels

(Ethanol–Ether)

Project Title	Needs and Objectives
Ethanol production from sugar beet substrates: controlling the fermentation stage 1995	Bioethanol, produced in part by distilling beet juice, is used for the synthesis of ETBE, an oxygenate additive in unleaded gasoline. The cost price of bioethanol is currently higher than that of gasoline. One way of reducing its cost is to optimise the production processes, especially the fermentation stage. In fact, a phenomenon of non-sterile medium contamination causes a decrease in yield, and we do not understand the origin or mechanism of this contamination. Basic research on the contamination processes is needed. The objective of this study is to control the fermentation stage in ethanol production from sugar beet substrates. The first stage will focus on analysing the behaviour of S. cerevisiae and of the contaminant in model media. The second stage will consist in studying the behaviour of fermentation with S. cerevisiae during the contamination of the medium. The third stage will attempt to identify the conditions favourable to implantation of the contaminant. The fourth phase will determine the procedural conditions in which satisfactory fermentation activity of the desired S. cerevisiae strain can be guaranteed.

Project Title	Needs and Objectives
Structural basis of fragmentation and fractionation of cereal grains: influence of pretreatment on mechanical properties and aptitude for separation 1995	The grain fractionation technology used today for production of non-food-use wheat is identical to that employed for food-use wheat, namely, milling to obtain flour followed by wet separation of starch and proteins. This process was optimised for food production, however, and presents technological and economic limitations for non-food applications. It would be useful to study other wheat fractionation methods in order to find a better adapted procedure, which would be more cost-effective and also more selective for components with possible non-food uses. The goal of this research is to study the structural bases of wheat fragmentation and fractionation in order to optimise dry fractionation and to facilitate non-food utilisation of cereal grains and their derivatives. The first stage will examine the rheological and fragmentability properties of the kernel and the whole grain. The second stage will study the structure, composition and aptitude for fractionation. The third stage will formulate recommendations for optimising pretreatment and fractionation procedures.

Project Title	Needs and Objectives
Optimised ethanol production from wheat by coupled fermentation/flocculation 1995	Bioethanol is produced by wheat or beet distillation and is used to synthesise ETBE, an oxygenate additive used in the formulation of unleaded gasolines. The cost price of bioethanol is higher than that of gasoline at the present time. One way of reducing this cost would be to develop a continuous fermentation process. It has been observed that certain strains of yeast have the tendency to aggregate. This property could make it possible to develop new technology for continuous fermentation by coupling fermentation and recycling of yeasts by flocculation. The aim of this project is to develop this new coupled fermentation/flocculation technology. The first stage will isolate and identify the micro-organism or micro-organisms involved in deflocculation. The second stage will attempt to describe the mechanisms and the kinetics of propagation of the contaminant. The third stage will focus on finding the cause of floccule dispersion. The fourth stage will attempt to find a way to stabilise continuous fermentation by flocculent yeasts. The findings for wheat will then be tested on sugar-beet juice.

Project Title	Needs and Objectives
Identifying technological criteria in order to draw up terms of reference for improving the economics of producing ethanol from wheat 1995	Bioethanol is produced, in part, from wheat. The alcohol extracted by distillation is then chemically converted into ETBA, an additive used in unleaded fuels. At present there exist no terms of reference optimised for production of wheat for conversion to ethanol. It would be interesting to establish such terms of reference determining optimum technical, economic and environmental conditions for producing bioethanol. The aim of this project is to identify the technological criteria for ethanol wheat crops needed in order to draw up industrial terms of reference, and then to assess genetic variability in wheat and the sensitivity of different wheat varieties to agronomic conditions. The first stage will exploit existing data to determine the criteria that influence process performance. The second stage will validate these criteria using simple physical analyses. The third stage will be devoted to setting up a test network using the best cultivars. In the fourth stage a pilot project will be developed to validate the earlier results. Lastly these results will be verified on an industrial scale by BENP.

Liquid biofuels

(Ethanol–Ether)

Project Title	*Needs and Objectives*
Agronomic pathways for wheat production 1994	Wheat is one of the major crops used to produce non-food agricultural commodities, and specifically bioethanol, which is used in the production of ETBE, an additive in unleaded gasoline. At present, bioethanol obtained from wheat is not cost-competitive with fuels such as gasoline. One way to make bioethanol production more cost-competitive is to improve wheat quality. Up until now, no work has been done on optimising the quality of wheat with the aim of producing bioethanol. The factors influencing wheat quality should therefore be identified. The goal of this project is to determine the characteristics of a variety of bioethanol wheat which would optimise the cost price of the industrial raw material without negatively affecting farmer income, and which would meet technological specifications. The first stage will concentrate on setting up rapid tests and developing a method of reference for evaluating the quality of wheat for bioethanol production. The second stage will focus on creating an inventory of existing varieties of wheat. In the third stage, samples of varying qualities will be produced and characterised. The fourth stage will concentrate on using the test results and summarising them.

Liquid biofuels

(Miscellaneous)

Project Title	Needs and Objectives
Development of a cost-effective process for the synthesis of glycerol carbonate 1999	Glycerol carbonate is a multifunctional molecule with considerable potential for development as a substitute for other types of currently expensive chemically-derived carbonates. Previous promising studies have developed a new synthesis pathway for obtaining glycerol carbonate from a carbon-containing organic substance and glycerol in the laboratory. This synthesis could make possible the production of marketable commodities from glycerol, which is a coproduct of biodiesel (vegetable oil methyl esters), a liquid biofuel currently used in diesel engines. Thus, it would be useful to pursue these studies in order to optimise the synthesis reaction and to validate the possibility of its extrapolation to industry. The goal of this project is to develop the reaction between glycerol and a carbon-containing mineral source to produce glycerol carbonate at a competitive cost, and in conditions that can be extrapolated to industry. The first stage will focus on defining the steps of the reaction. In the second phase, the carbonatation of glycerol will be carried out first in a 250 ml reactor, then in a 2-litre reactor. In the last stage, a 25-litre reactor will be used.

Project Title	Needs and Objectives
Marketable commodities from beet ethanol vinasse coproducts 1998	Vinasse is a coproduct of bioethanol production. Bioethanol is a compound which, chemically modified, gives ETBE, an additive used in the formulation of unleaded gasoline. Beet vinasse is rich in betaine, a compound currently used in livestock feeds as a liver disease prophylactic. The cost of bioethanol today is higher than that of fossil fuels. One way to lower its cost is to maximise the value-added processing of bioethanol coproducts. One possibility worth exploring would be to develop marketable commodities for the livestock feed market using beet vinasse betaine. The objective of this project is to derive value-added commodities from beet vinasse, and in particular from betaine. The first phase will consist of a marketing study of the poultry and pig feed market, and the second phase will target the cattle feed market. The third stage will focus on fine-tuning the chromatic separation of vinasse, the feasibility of a liquid betaine/glycerol concentrate and the conditions for obtaining crystallisation of betaine HCL. The fourth stage will be devoted to developing the industrial process and to validating it economically. In the fifth stage, the remaining questions and problems will be addressed.

Project Title	Needs and Objectives
Hydrogen production by reforming ethanol in a membrane reactor to supply a fuel cell 1998	A fuel cell is an electric generator which uses chemical energy produced when hydrogen reacts with oxygen. Fuel cells perform better than the turbines and engines used today. Due to their mobility, the principal potential application for proton-exchange fuel cells is in the transport sector. Methanol is one of the fuels currently used to produce hydrogen for fuel cells, but its toxicity is a problem. Ethanol could be another, less toxic source of hydrogen. There has been little study on reforming ethanol for the purpose of producing a purified hydrogen flow (absence of carbon monoxide) compatible with currently available fuel cells. The goal of this project is, firstly, to develop the catalysts and/or series of catalysts capable of breaking ethanol down into a mixture rich in hydrogen and in CO2, and secondly, to couple this reaction with the selective separation of hydrogen in a membrane reactor. The first stage will be devoted to developing the catalysts. The second stage will focus on increasing the selectivity of hydrogen and on improving overall efficiency.

Project Title	Needs and Objectives
Extraction and purification of plant hormones derived from products and coproducts of rapeseed methyl ester processing, for cosmetics applications 1997	Plant hormones play a regulatory role in plant metabolism. They present similarities with human hormones, giving them useful pharmacological and biological properties for high added-value applications, particularly in cosmetics. The coproducts of bioethanol, a liquid biofuel resulting from the esterification of rapeseed oil, are a potential source of plant hormones. It would be useful to determine if the applications of these coproducts could be expanded by developing a process of extracting plant hormones from rapeseed. The aim of this study is to determine the nature and potentialities of value-added processing for cosmetics applications of coproducts such as the plant hormones extracted during grain conversion of rapeseed. A bibliographic study will be carried out in the first stage. The second stage will concentrate on developing analytic methods for the identification of sterols. The third stage will focus on the extraction protocol for the liquid and solid products of the RME processing chain, including an investigation of storage conditions for sample sets, a characterisation of the feedstock and coproducts of the sample sets, extraction and purification.

Liquid biofuels

(Miscellaneous)

Project Title	Needs and Objectives
Use of beet pulp to treat heavy-metal effluents 1997	Beet pulp is a coproduct of bioethanol, which is a compound used for synthesising the unleaded gasoline additive ETBE. This coproduct could find a value-added application as a filtering material for the elimination of heavy metals in industrial wastewater. Previous research has shown that beet pulp can fix heavy metals in an aqueous phase. These findings have not yet been confirmed in large-scale tests. The objective of this project is to undertake a study of the fixation of heavy metals on a large scale using beet pulp. The first stage will comprise a study of ion fixation by beet pulp. The second stage will include a study of beet pulp's hydratation properties and aptitude for pressing. The third stage will be devoted to studying the incineration of beet pulp in a calorifier, in order to precisely determine the minimum dry matter content to be obtained for good energy performance. The fourth stage will include an economic evaluation of the procedure, and recommendations for its industrial use will be put forward.

Project Title	Needs and Objectives
Economic comparison of mass-market non-food uses in France 1996	With the implementation of land set-aside policies, large-scale cultivation of non-food crops has begun, notably for the purpose of liquid and solid biofuel production. Cultivation of these crops has non-commercial consequences, an environmental impact for one, which justify state involvement. Today, several non-food crops are grown, and it is important to conduct a study comparing these crops in terms of all their relevant impacts. Such a study would be an aid to public policy decisions (levels and distribution of subsidies). The objective of this project is to develop an integrated micro- and macro-economic methodology for biofuel processing based on data organised according to region. The first phase will concentrate on micro-economic analysis. The second stage will be devoted to multicriteria analyses, with the aim of evaluating in greater detail the various non-food processing chains. The third phase will study macro-economic developments. This project is part of the wider-reaching AGRICE programme no. 95 01 083.

Project Title	Needs and Objectives
Updated analysis of the VoME life-cycle and VoME biodegradability and ecotoxicity 1996	The principal motivation for developing biofuels such as biodiesel (vegetable oil methyl esters) is the lesser impact these fuels are assumed to have on the environment. A biodiesel life-cycle analysis and an environmental assessment were carried out in 1993 in order to demonstrate its positive impact on the environment. Since then, new scientific and technical findings have been published, mainly concerning agricultural production, but also in the area of biodegradability and ecotoxicity. It is therefore important to update the 1993 environmental impact studies. The goal of this project is, firstly, to update the life-cycle analysis (LCA) and secondly, to measure the biodegradability and ecotoxicity of certain vegetable oil methyl esters (VoME). The first phase will be devoted to reviewing the updated theories and references for developing the biodiesel LCA and to bringing the 1993 environmental assessment summary up to date. The second stage will concentrate on updating the bibliographic data on VoME biodegradability and ecotoxicity as well as its toxicity for mammals, bacteria, fish, algae, and daphniae.

Project Title	Needs and Objectives
Producing fuel and fertiliser from rapeseed cake 1996	Rapeseed presscake is a coproduct of biodiesel, a liquid biofuel produced from rapeseed and used in diesel fuel blends. Rapeseed cake could be commercially exploited in order to improve the overall economic competitiveness of biodiesel production. Using rapeseed as a fuel and as an organic fertiliser are two possible value-added applications which could be rapidly evaluated and put to use if they test well. The goal of this project is to evaluate the technical and economic feasibility of these two approaches. The first stage will focus on the combustion process. Several steps will be studied: formulation; characterisation of the triphasic blends, characterisation of the pulverisation; and combustion. The second stage will concern fertiliser production, and will include the study of the kinetics of nitrogen mineralisation of several varieties of rapeseed cake as well as the test application of rapeseed cake used as an organic fertiliser.

Liquid biofuels

(Miscellaneous)

Project Title	Needs and Objectives
Energy balances of biofuel crops 1996	One of the reasons for developing biofuels in France is the hope they would have less impact on the environment than petroleum-based fuels. To scientifically demonstrate this environmental advantage, however, an overall energy balance must be established, encompassing agricultural crops in particular. At present we do not have enough data to establish these balances. It will therefore be necessary to draw up a reference database in order to establish these balances. The aim of this project is to elaborate this reference database for energy crops (wheat, beets, rapeseed, sunflower, and even sorghum). In the first stage methodology will be established, working with the INRA research body. The second stage will be devoted to identifying crop pathways and listing the reference needs (costs, energy values). The third stage will identify available data on energy content, as well as the hypotheses and rules of calculation currently accepted for work on this subject. The fourth stage will focus on elaborating the reference database. The fifth stage will proceed with formalisation of this database for integration in the Ecofil software.

Project Title	Needs and Objectives
Environmental assessment of ethanol production 1995	Bioethanol, produced from sugar-beets, is used for the synthesis of ETBE, which is an analogue of the chemical compound MTBE. These compounds are oxygenated additives that have the advantage of a good octane rating and also reduce the quantity of unburned matter and carbon monoxide in exhaust gases. Up until now, no one has undertaken an environmental audit of producing ethanol from sugar-beets and MTBE by petrochemical processes. These two products should be environmentally assessed and compared in order to determine whether products obtained from renewable resources have a positive impact on the environment. The goal of this study is to undertake an economic assessment of the production of beet bioethanol intended for the synthesis and utilisation of ETBE. The factors to be studied which pertain to beet-crop cultivation are: NPK fertilisation; crop protection; use of tractors; leaching and transport/ensilage. The data will be processed in the first stage. The second stage will consist of an economic assessment of ETBE production. In the third stage, the same factors will be examined for MTBE production. Finally, the last stage will focus on an analysis of the environmental impact of ETBE production and utilisation.

Project Title	Needs and Objectives
Economic comparison of mass-market non-food uses in France 1995	With the implementation of land set-aside policies, large-scale cultivation of non-food crops has begun, notably for the purpose of liquid and solid biofuel production. Cultivation of these crops has non-commercial consequences, an environmental impact for one, which justify state involvement. Today, several non-food crops are grown, and it is important to conduct a study comparing these crops in terms of all their relevant impacts. Such a study would be an aid to public policy decisions (levels and distribution of subsidies). The objective of this project is to undertake an economic comparison of mass-market non-food processing chains on a national scale, and to develop an integrated micro- and macro-economic methodology based on data organised according to region. The first phase will concentrate on developing technical and economic agricultural data. The second stage will concentrate on micro-economic analysis of a number of paper processing chains. The third phase will be devoted to analysis by region of demand for coproducts for livestock feed. The fourth stage will comprise developing and testing the micro-economic model, in particular for liquid and solid biofuels. This stage falls under agreement no. 95 01 083.

Project Title	Needs and Objectives
Simultaneous processing of rapeseed methyl esters (RME) and glycerol 1995	Glycerol is a coproduct of biodiesel, which is derived from rapeseed or sunflower and can be blended with diesel fuel. This coproduct could be commercially processed as an intermediate chemical for the synthesis of speciality products such as lubricants. Glycerol converted into glycerol carbonate is a reagent of choice that can be made to react, for example, with rapeseed methyl esters themselves. It would be useful to validate these syntheses and to test the properties of the products obtained in order to find market outlets for them. The aim of this project is to study the simultaneous, value-added processing of rapeseed methyl esters and glycerol. The first stage will study the acylation of glycerol carbonate by esterification. The second stage will study the acylation of glycerol carbonate by transesterification. The third stage will examine the acylation of glycerol carbonate in the presence of acid chlorides. The fourth stage will be devoted to evaluation and performance testing of the products for uses as lubricants, plastifiers and emulsion agents.

Liquid biofuels

(Miscellaneous)

Project Title	Needs and Objectives
Use of protein-rich distillery sludge 1995	Wheat vinasse is a coproduct of bioethanol, which is one of the principal non-food agricultural commodities and serves for the synthesis of ETBE, an additive used for the formulation of unleaded gasoline. This vinasse is rich in protein that could be commercially exploited in order to make the wheat/bioethanol processing chain more cost-competitive. At the present time, the obstacle to value-added processing of these proteins is the lack of efficient purification processes. Thus, it would be useful to develop a new process for the extraction and purification of these proteins. The aim of this project is to adapt the method of protein concentration developed by ARD for wheat flour to the protein-rich sludge produced by the Provins distillery. The first phase will be devoted to verifying the results obtained in the laboratory at the pilot stage. The second phase will focus on a closer study of the protein-rich sludge's aptitude for hydrolysis. The third stage will comprise atomisation trials on the hydrolysed sludge, at the pilot level. In the fourth stage, membrane tests will be conducted to optimise the qualitative parameters of the peptides. The fifth stage will concentrate on analysing the functional properties of proteins. The sixth stage will include pilot testing of the machines.

Project Title	Needs and O"jectives
Biomethanol production costs 1994	At the 0resent time, natural gas is the principal raw material used to produce methanol, which is a precursor of the fu%l additive MTBE. Methanol can also be produced from biomass, however, by a process including gasification. The %conomic competitiveness of such a production process must be established before undert!king any project on this subject. The !im of t(is study is to determin% the technical and economic advantages of methanol prod5ction based on obtaining syngas from biomass, and to investigate the opportunities for developing such production in France. The first stage of this project will look at the technology and the industries involved (state-of-the-art syngas production technology, origin and availability of technology under patent, industries concerned by this technology and production process). The second stage will evaluate biomethanol production costs. The third stage will examine the cost competitiveness of biomethanol in comparison with other sources of methanol (gas and coal). The fourth stage will be devoted to summarising and interpreting the project findings.

Project Title	Needs and Objectives
Non-food uses for coproducts of wheat and beet biofuel production. Enzymatic pathways to new biomaterials 1994	Ethanol production for fuel use by wheat or beet fermentation generates coproducts, such as wheat bran or draff and beet pulp, which have few or no value-added applications today. These coproducts, however, are known to be rich in natural polymers such as pectins and heteroxylanes which could be used as feedstocks for producing plastic-like materials that are more environmentally friendly than synthetic materials. Using enzymatic polymerisation, in particular, would allow the development of a production process which is cleaner than the less-selective chemical conversion. The objective of this project is to study an enzymatic process for producing a film from bioethanol processing coproducts. The first stage will be devoted to obtaining well-characterised substrates from draff and pulp. The second phase will concentrate on purifying and characterising the fungal metalloenzymes and utilising them for the cross-linking of pectins and feruloylous heteroxylanes. The third stage will focus on obtaining films from the cellulosic residues.

Project Title	Needs and Objectives
Selection of non-food crops and uses based on hierarchical ranking of economic objectives and use of spatially projected agricultural data 1994	LThe bases have been defined to create a tool for comparison of different chains of activity in non-food feedstocks and products. This kind of tool is needed to compare the activity chains for liquid vehicle biofuels and solid biofuels. This type of tool could also apply more broadly to the selection of non-food crops and uses nationally. The aim of this project is to establish a multi-crop and multi-product model covering the country, region by region. The first step will be to choose an algorithm to resolve the models, in collaboration with CORE (Louvain-la-Neuve) and the University of Texas. In the second stage spatially projected technical and economic data on non-food crops will be gathered.

Solid Biofuels

Project Title	Needs and Objectives
Modelling of cogeneration with biomass production 2000	World energy consumption currently confronts us with two major problems: pollution and future supply, potentially jeopardised by steadily rising consumption. In the present circumstances, biomass could serve as an alternative energy source which would not accentuate the greenhouse effect. Developing electrical energy production from biomass in economically viable conditions requires a homogeneous and cost-competitive resource, optimal conditions of mobilisation, a guaranteed and stable supply, and conversion technology for optimising electricity production and utilising heat. The objective of this project is to study and model the integration of biomass production for energy uses, from the stage of collection and production, to the stage of conversion to heat and energy by cogeneration. The first phase will concentrate on a detailed establishment of the various stages of the study. The second stage will be devoted to developing an economic assessment model and to discussing the theories and findings. The third stage will comprise a sensitivity analysis and a summary. The fourth stage will present possible organisational schemes and develop site selection grids.

Project Title	Needs and Objectives
Robust non-linear controls of methanisation processes 1999	World energy consumption confronts us with two major problems today, namely, the problem of pollution (transfer of chemicals from mineral deposits to bio-geochemical cycles, such as that of carbon), and future supply, jeopardised by ever-increasing consumption. In the present circumstances, biomass could serve as an alternative energy source which would not accentuate the greenhouse effect. One marketable energy use for livestock or food industry effluents is the production of biogas by fermentation. One of the obstacles to developing the use of this technology in industry is the lack of a system of controls adapted to the complexity of the processes and, in particular, to the non-linear nature of the phenomena involved as well as the variability, in both quantity and composition, of the inputs. The objective of this project is to develop a generic system of robust controls capable of guaranteeing the stability and performance of a methanisation process in the presence of external disturbances which could affect its operation. The process to be used to validate the experimental approach of this study is a process of fixed-bed methanisation for processing wine vinasse, but it should be noted that this strategy can be adapted to all types of reactors. The project comprises three distinct stages: first of all, the installation of sensors and a measurement campaign to collect the data necessary to validate a model for characterising the behaviour of the process in different operational configurations; next, the validation of the model, properly speaking; and finally, the execution and validation of a control algorithm.

Project Title	Needs and Objectives
Producing activated carbon for purification of liquids 1999	LActivated carbon is a material widely used for treating liquid and gaseous wastes because of its adsorption properties. At present, it is obtained by a special process of treating mineral-derived coal. An earlier AGRICE project validated the feasibility of producing activated carbon from lignocellulosic biomass, such as straw, and not from coal. It appears necessary to pursue this work for a range of pollutants, with the same reactors and new biomass materials. The aim of this project is to optimise the quality of the activated carbon derived from straw and bran, or from beet pulp. The first stage will be a laboratory phase. The work will focus on developing feedstocks, carrying out carbonisation/activation, characterising the activated carbon obtained and conducting preliminary applications testing. The same segments will be repeated in the second stage, which will be an extrapolation of the pilot processes.

Solid biofuels

Project Title	Needs and Objectives
Growing SRC willow for purifying pretreated water, white water and sludges 1998	Wastewater treatment generates large quantities of potentially polluted sludge which is more and more difficult to use as fertiliser for food crops in the present context of growing public concern about food quality. Very short rotation coppice (SRC) willow is a perennial grown for heat production and which can also be used very efficiently to eliminate pollutants (phosphates, nitrates and heavy metals). It would be useful to study the use of sludge as a fertiliser for non-food crops, such as SRC willow. The objective of this project is to develop an energy-use crop in a region (Brittany) where re-establishing water quality is a current issue. The project will focus on 10 hectares planted in 1998. The first phase will demonstrate the purifying capacity of SRC willow. The second stage will show the purifying capacity of SRC willow when irrigated with organic effluents. The third stage will study the possibility of planting SRC willow on unoccupied land and/or with the aim of developing wild fauna.

Project Title	Needs and Objectives
Codigestion of swine slurry and fermentable agricultural products for energy use of biogas 1998	World energy consumption currently confronts us with two major problems: pollution and future supply, potentially jeopardised by steadily rising consumption. In the present circumstances, biomass could serve as an alternative energy source which would not accentuate the greenhouse effect. Non-polluting outlets for agricultural and urban waste must be found. It would be useful to exploit waste commercially to produce energy. The goal of this project is to study the development of codigestion of swine slurry and fermentable agricultural and urban waste with the aim of producing energy from biogas and creating agronomic uses for methanisation effluents in the Montardon area (Pyrénées Atlantiques). The first stage will be devoted to investigating methods of conducting a codigestion trial on the AGPM methanisation platform. The second stage will focus on product characterisation and a pilot codigestion simulation in the laboratory. In the third stage, the experiment will be installed on site. The fourth stage will look at the technical, energy, economic and environmental aspects of the trial.

Project Title	Needs and Objectives
Conception and design of a thermal purifying process for gases released by biomass gasification 1997	World energy consumption currently confronts us with two major problems: pollution and future supply, potential,y jeopardised by steadily rising consumption. In the present circumstances, biomass could serve as an alternative energ9 source which would not accentuate the greenho5se effect. The efficiency of gasification processes cur2ently used in small-capacity plants that generate power from biomass suffers because of the presence of tar in the gases, and this decreases th% output of the installa4ions. A technical solution to this problem shou,d be found. The goal of this project is to develop a thermal purifying process for gases which would prevent this energy loss. The first stage will be devoted to testing of combustion/vitrification of gasifier coke. The second stage will develop a kinetic model for the devolatilisation/combustion of coke. The third stage will be devoted to size optimisation and to the implementation of a 50 kg/hour pilot operation. The fifth stage will present the study's conclusions and a report.

Project Title	Needs and Objectives
Methanisation of lignocellulose 1997	Methanisation is a process for treating solid organic waste by anaerobic digestion to obtain biogas, used commercially for heat production, and residual organic matter, used as fertiliser. One of the limitations of this process for treating plant matter is the high proportion of lignocellulose, the hydrolysis of which seems to limit the following stages of anaerobic digestion. In order to overcome this limitation and to promote methanisation of plant biomass, it is necessary to find ways to accelerate the hydrolysis stage of the process. The objective of this project is two-fold: firstly, to remedy the currently existing limitation on lignocellulose degradation by determining how to increase the growth of cellulolytic micro-organisms, which is a fundamental stage in the cell growth cycle; and secondly, to study the impact of introducing massive quantities of biomass into the methanisation reactor.

Solid biofuels

Project Title	Needs and Objectives
Biofuel production: comparison of woody filler crops and intercropping 1996	In hardwood cultivation (walnut, cherry), tree density is kept low in order to obtain high-quality wood. This type of cultivation leaves a large space between trees, which could be exploited by intercropping with plants to be used for biofuel production. This new cultivation technique has not been optimised; specifically, the best choice of woody and annual plant species has not been determined. Further research is needed to optimise this cultivation technique. The goal of this project is to test and compare two possible types of intercropping for biofuel production, from both a biotechnical and a technical/economic point of view. The first phase will evaluate how the filler crops affect the growth of the hardwoods. The second stage will evaluate the effect of the trees on the growth and yield of the filler. The third stage will comprise an estimation of the equivalent yield coefficient. The final stage will be devoted to evaluating the effect of woody filler crops on hardwood growth.

Project Title	Needs and Objectives
Competing with fossil fuels and competition between different usages of woody materials 1996	Wood production in Lower Normandy amounts to 2,250,000 tonnes annually. One-third of this resource goes unused, and could be transformed into energy. The "Fuelwood and local development" programme has been set up to this end in Lower Normandy. To provide the best orientation for this programme, greater knowledge is needed of the different woody materials available and how they could be used in a context of competition with fossil fuels. The aim of this project is to study the competition between fossil fuels and biofuels, so that the operators in this sector can establish long-term strategies. The first stage will be devoted to analysis of the cost-effectiveness of each of the projects. The second stage will assess the public expenditure and integration of external costs. The third stage will look at competing uses and mobilisation of woody materials; this will be a study of current uses of woody wastes. The fourth stage will seek out synergies between feedstocks of various sorts: forestry and agricultural products, wastes and less noble byproducts.

Project Title	Needs and Objectives
Miscanthus: the new "green" coal? 1996	Miscanthus is a plant considered to be very similar to sugar cane. Cultivation of this plant in other European countries indicates that it gives high biomass yield. This high yield could make it profitable to grow Miscanthus on set-aside land for the production of new energy-use biomass. The technical data on Miscanthus are weak, disparate and sometimes contradictory, however. Better knowledge of this plant is needed in order to measure its potential. The goal of this project is to develop economic methods for producing Miscanthus by studying, in particular, ways of optimising its cultivation on set-aside agricultural land and the acclimatisation behaviour of young plants. The first phase will consist of developing, in France, the know-how required to develop an exploitable germ plasm and to master both its conservation and variability. The second stage will concern the most economical methods of multiplication of this plant, in order to lower significantly the cost of introducing it. In the third stage, the multiplication method will be validated. The fourth stage will be devoted to presenting the findings in an accessible form for use by the agricultural sector.

Project Title	Needs and Objectives
Treatment and value-added processing of biomass by methane fermentation 1996	Methanisation is a biological process for converting organic raw material into biogas, which can then be used commercially to produce energy. Previous AGRICE research has shown the technical and economic feasibility of value-added processing of agricultural biomass combined with other sources of organic matter for the production of biogas in a rural environment. This research also identified a potential impediment to such production, i.e. that methanisation of lignocellulosic materials is difficult. Further study is needed to optimise the methanisation of lignocellulose. The objective of this project is to study and further develop certain aspects of methane fermentation of plant crops and of different combinations of organic wastes. The first phase will be devoted to assessing how the principal operational parameters of a continuously supplied digester influence the methanogenic potential of a substrate mixture, specifically one containing lignocellulosic products. The second phase will aim to determine how the plant's ripeness influences the expression of its methanogenic potential and to evaluate the technical and economic constraints of agricultural production of the crops under study.

Solid biofuels

Project Title	Needs and Objectives
Production of activated carbon from cultivated plants for wastewater treatment 1996	Activated carbon is a material widely used for treating liquid and gaseous wastes because of its adsorption properties. At present, it is obtained by a special process of treating mineral-derived charcoal. Today, in the context of the land set-aside policy, a considerable quantity of lignocellulosic material can be potentially mobilised as raw material, i.e. SRC and various straws. It would be useful to determine if producing activated carbon from this cellulosic biomass by carbonisation would be technically and economically viable, taking into account the subsequent commercial use of this activated carbon to produce energy. The goal of this project is to develop the production of activated carbon from plant raw material. The first phase will focus on a preliminary identification of the market and determination of strategy orientation. The second stage will concern the identification and characterisation of products from energy-use plants and their adsorbent properties. The third stage will be devoted to determining the conditions of destruction by incineration of the saturated activated carbon. The fourth stage will centre on optimisation of the conditions of preparation and conditions of utilisation based on feedback. The fifth stage will be devoted to a technical and economic analysis of the process.

Project Title	Needs and Objectives
Combustion of rapeseed-derived raw oil, vinasse and heavy fuel-oil for heat production 1996	Vinasse is a coproduct of bioethanol, a biofuel obtained from wheat or beets. This vinasse could be used commercially as fuel in combination with heavy fuel oil in boilers, and in industrial drying boilers in particular. The financial, economic and environmental feasibility of such an approach is yet to be validated, however. The goal of this project is to test the impact of using biofuels as a partial substitute for heavy fuel oil in practice, at the Artenay Cooperative production site. The first stage will focus on optimising the appropriate blend proportions for the formation of microemulsions, for meeting the required energy demand, and for responding to economic constraints. The second stage will focus on quantifying and qualifying the residual organic and mineral fractions in the gases, particles and pulp. The third stage will consist in optimising combustion using different types of industrial boilers.

Project Title	Needs and Objectives
Thermochemical treatment of biomass to obtain value via pyrolysis 1996	World energy consumption confronts us with two major problems today, namely, the problem of pollution and future supply, jeopardised by ever-increasing consumption Under these circumstances, biomass could serve as an alternative energy source which would not accentuate the greenhouse effect. But the complexity and diversity of biomass precludes a simple use of this resource, instead all possibilities for transforming biomass into more homogeneous products must be investigated. The aim of this study is to analyse the primary processes of thermal decomposition of biomass in relation to production of solid biofuels, liquid vehicle fuels, or chemical feedstocks. In the first stage complete knowledge of the primary processes in biomass degradation will be acquired. The second stage will be devoted to demonstrating the existence of a very short-lived intermediary species. In the third stage results obtained for cellulose, lignin, etc. will be extrapolated to the biomass material itself. The fourth stage will see transposition of these results to practical examples, by creating parallels between model situations in the study and conditions existing in real-life processes.

Project Title	Needs and Objectives
Modelling grassy and lignocellulosic crop production on a regional scale 1996	In the context of land set-aside policies, non-food crops are being grown in significant quantities, in particular for producing biofuels. Technical and economic references that span soil and climate conditions are lacking for creating a supply and processing chain to raise lignocellulosic crops as feedstocks for valuable products on a regional scale. In these circumstances it is difficult to prepare industrial projects because the availability and cost of raw materials are unknown. This project aims to apply a method for estimating biomass production levels for certain lignocellulosic crops and their variability in time and space, on a regional scale. The first phase will be devoted to a study of crop production and variability. The second phase will estimate environmental impacts. The third phase will be devoted to spatial analysis of production variations. The fourth phase will consist of an analysis of opportunity costs for the insertion of lignocellulosic crops.

Solid biofuels

Project Title	Needs and Objectives
Production of a liquid fuel by pyrolysis of aqueous-phase biomass in the presence of hydrogen 1996	World energy consumption confronts us with two major problems today, namely, the problem of pollution and future supply, jeopardised by ever-increasing consumption. In the present circumstances, biomass could serve as an alternative energy source which would not accentuate the greenhouse effect. With the technology that exists today (carbonisation and gasification), biomass such as straw or wood yields only solid or gaseous fuels. Developing new technology to produce liquid biofuels would open up new markets for energy-use biomass. The goal of this project is to study a new concept of thermochemical liquefaction of wood. The first stage will be devoted to an update on international research done in this area. The second stage will consist of laboratory tests to determine the best conditions for carrying out the procedure and to assess the material and energy requirements. The third stage will produce a technical and economic evaluation of industrial application of this process.

Project Title	Needs and Objectives
Evaluation of potential uses and production costs for lignocellulosic and grassy plants 1995	In the context of the land set-aside policy, cultivation of many annual and perennial plant crops is planned in order to produce biomass for commercial use as a source of energy, materials and biomolecules. At present, our knowledge of each of these crops and their non-food characteristics, both agricultural (yield, production costs, etc.) and technical (energy source potential, etc.), is not sufficient to be able to evaluate their potential. It is therefore necessary to supplement the existing data. The goal of this project is to produce a written overview of all the characteristics of the grassy plants that are grown, which will afford a better understanding of the advantages and limitations of these plants with regard to producing biomass for non-food uses. The first stage will study the needs of the different utilisations of biomass and the zoning of crop cultivation. The second stage will focus on the production that can be attained using annual or perennial grassy plants under different soil and climate conditions. The study's findings will be summarised and presented in the third stage. The fourth stage will consist in producing technical reports for dissemination.

Project Title	Needs and Objectives
Installation of an industrial pilot plant for producing methane fuel from biomass in a rural area 1995	Methanisation is a biological process for converting organic raw material into biogas, which can then be used commercially to produce energy. The implementation of the land set-aside policy has created the potential for growing non-food use crops, for which outlets need to be developed. It would be useful to evaluate the technical and economic feasibility of producing biogas in rural areas from these crops in combination with other organic material, such as livestock effluents or municipal wastewater sludge. The aim of this project is to determine the feasibility of setting up a biomass methanisation industrial pilot in a rural area. The first stage will study substrates and treatability in order to confirm in practice a number of theories regarding energy-use crops' potential for producing biogas, and to assess the performance of anaerobic digestion in polysubstrates. The second stage will consist of an in-depth technical and economic study of the processing chain, which will analyse production conditions and/or mobilisation of the biomass resource on at least one preselected site.

Project Title	Needs and Objectives
SRC eucalyptus: harvest modelling 1995	Short-rotation coppice (SRC), a cultivation method for ligneous plants such as poplar, is based on agricultural rather than forestry techniques: cultivation does not take the form of forests, but is carried out on agricultural land; plant density is very high; and harvesting is done mechanically using specific agricultural machinery, on a rotation of a few years rather than scores of years, as in forest farming. SRC has been studied since the beginning of the 1980s because of its potential outlets in both paper manufacturing and energy production. Eucalyptus planted 10 years ago are being progressively exploited. It is now time to develop forecasting tools for these crops, on a single-plot scale. The objective of this project is to establish methods for estimating the productivity of this new species. The first stage will concentrate on establishing volume tables. The second stage will be devoted to developing a method for estimating the quantity of marketable wood contained in the trees. The third stage will cover the development of productivity and cost models for felling and logging. The fourth stage will compare this study's findings with the data collected on SRC poplar. The fifth stage will focus on determining harvest conditions, and the sixth stage will analyse the technical and economic impact.

Solid biofuels

Project Title	Needs and Objectives
Cofiring of biomass with carbon-containing wastes. Impregnation of pollutants on lignocellulose. Evaluation of use for soil clean-up 1995	Fuelwood has been shown to be economically viable today in France for use in building boiler plants and in certain industries. Agricultural biomass, especially coproducts such as maize stalks or husks, could also be commercially processed for energy production. One way to accelerate the use of agricultural biomass for energy production would be to validate the cofiring of this biomass with carbon-containing industrial wastes, which would improve their cost-competitiveness when the income generated by sales to the waste removal industry is subtracted from the cost of the biomass. The goal of this project is to carry out the cofiring of agricultural or forest biomass with carbon-containing wastes or with pollutants, using the lignocellulosic biomass as a porous absorbent material. The first phase will centre on preparing and characterising the raw materials. The second stage will be devoted to preparing and implementing the use of the fuels, blending additives, formulating, firing and tests. The third stage will consist of an economic evaluation of the fuel and the production process. The fourth stage will be devoted to a summary report.

Project Title	Needs and Objectives
Research programme on SRC poplar plantations 1994	Short-rotation coppice (SRC), a cultivation method for woody plants such as poplar, is based on agricultural rather than forestry techniques: cultivation does not take the form of forests, but is carried out on agricultural land; plant density is very high; and harvesting is done mechanically using specific agricultural machinery, on a rotation of a few years rather than scores of years, as in forest farming. SRC has been studied since the beginning of the 1980s because of its potential outlets in both paper manufacturing and energy production. The first INRA studies identified poplar as one of the most promising trees. It is now important, therefore, to optimise its cultivation. The objective of this project is to improve the cultivation of SRCs. The first stage will monitor and make the most of SRC cultivation already in place on 20 hectares of SRC poplar. The second stage will be devoted to improving the poplar trees. The third stage will concern the chemical fertility of the soil and the supply of mineral nutrients. The fourth stage will centre on SRC poplar entomology.