Cavour and the Development of the Fertilizer Industry in Piedmont

MARIO LORIA

Today, mechanization and fertilizers are two basic factors of agricultural production. Yet only recently, during the difficult post-World War II period, has Italy begun to develop these systematically both as producer and consumer. One cannot, therefore, but appreciate the daring and modernity of Count Camillo Benso di Cavour,[1] who struggled to improve Piedmont agriculture in the face of tremendous odds.

While doing research on the introduction of rice-cultivating machinery to Piedmont,[2] which Cavour sponsored during the first half of the nineteenth century, I was impressed on reading his correspondence with Giacinto Corio[3] and Emile de la Rue[4] by his intense

Dr. Loria, of Turin, Italy, is an engineer who has written on the development of the chemical industry in mid-nineteenth-century Italy. He is the author of *Camillo Cavour e l'industria chimica dei concimi* (Turin, 1964). In preparing this paper for publication in *Technology and Culture*, Mr. Loria was assisted by H. Bruce Linn, Graduate Fellow in the History of Science and Technology at Case Institute of Technology.

[1] Cavour (1810–61), future premier of the kingdom of Sardinia and builder of Italian unity, was excluded, before 1848, from any governmental participation because of his liberal ideas. Cadet son of an aristocratic family, his early activities were those of a private citizen. As manager of the family farms (about 1,200 hectares) near Vercelli, he became interested in agriculture and, later, in the fertilizer industry.

[2] Mario Loria, "Il trebbiatoio da riso di Cavour (Leri–1844)," *Physis: Rivista di storia della scienza*, Fasc. I (1961); *idem*, "Il cavouriano molino da riso del Regio Parco in Torino," *Atti della Accademia delle Scienze di Torino*, Part I, Tome II: *Classe di Scienze Morali*, XCV, No. 2 (1960), 563–607, and Part II, Tome I: *Classe di Scienze Fisische*, XCV, No. 6 (1961), 928–69.

[3] Corio (1795–1870) had extensive farming experience and was appointed by Cavour in 1846 to manage his farms near Vercelli. In 1849 Corio became Cavour's associate. The letters from Cavour to Corio were published in the volume *Cavour agricoltore: Lettere inedite di Camillo Cavour a Giacinto Corio*, ed. Ezio Visconti (Florence, 1913).

[4] De la Rue (1802–70), a noted banker, his brother Hyppolyte, and his cousin David Julien founded the Genoan branch of the family's banking firm of Geneva, which began business in 1758. He was a close friend of Cavour and, particularly

efforts to find a practical fertilizer. This experimentation was not without its risks, but Cavour constantly strove to increase the yields of cereals and the value of livestock on his own farms and generously provided Piedmont farmers with the results of his attempts.

In almost every letter to Corio after 1846, but before Corio accepted the management of the Cavour farms at Leri, Monterucco, and Torrone (all in the province of Vercelli), Cavour mentions manure. An examination of Cavour's correspondence so far made public, as well as of some contemporaneous documents, reveals ample evidence of his early initiative; his continued interest resulted in the establishment of a chemical-fertilizer factory in Turin courageously financed by Cavour himself. While examining the Archivio di Stato in Turin for information about the early development of the chemical industry in Piedmont, I noticed a patent application made in 1844 by the Irish physician, Sir James Murray, who first produced superphosphates industrially in England. This shows that agricultural Piedmont was considered abroad to be a potential market. Cavour's factory of Rossi e Schiapparelli, which was established shortly thereafter, can therefore be regarded as the ancestor of the large Italian phosphoric fertilizer industry, which today plays a vital role in the national economy.

* * *

As his Vercellese farms produced insufficient fodder for his cattle, Cavour was obliged to buy it, although he considered this to be irrational and costly. Since he wished to develop cattle breeding and to increase the productivity of his corn and wheat fields,[5] he decided on practical fertilizing. His early attempts, however, were purely empirical, and the results were poor. His hopes soared, however, with the use of guano.[6]

Cavour often mentioned guano in his letters to Corio, but not until October 26, 1846 did he mention it in a letter to his friend De la Rue.[7] Angelo Abbene, a chemist of Turin, highly esteemed by Cavour, was

---

before 1848, was his financial adviser for his industrial activities. Cavour's letters to De la Rue were published in French in Amédé Bert (ed.), *C. Cavour, nouvelles lettres inédites* (Rome, Turin, Naples, 1889).

[5] Rice, the main product of Cavour's farms, remained out of the question, as it grows in water, where fertilization has a much less important role.

[6] Guano, beginning with its systematic exploitation in Cavour's times, had a decisive impact on Peruvian politics for many years; see Antonello Gerbi's concise and brilliant chapter "L'era del guano" in *Perù* ("Nazioni," Vol. I [Milan, 1961]).

[7] Cavour to De la Rue, Turin, October 26, 1846, in Bert (ed.), letter 47.

then entrusted with the analysis of the first samples of Peruvian guano. In one of his letters, Cavour remarks on the high content of uric acid, "qui est le plus précieux de tous les ingrédients," and encouraged De la Rue to buy the guano without further ado.

A valuable complement and thoughtful premise to the experimental fever of Cavour is the *Gazzetta dell'Associazione Agraria Subalpina.*[8] Its pages present a variety of arguments and concrete discussions—sometimes apologetic, at other times polemic. Cavour's strong influence on this eminently technical and professional journal is evident, and even the most casual comparison reveals the parallel between many of the *Gazzetta*'s themes and those of Cavour's letters. Although most of the articles are unsigned, probably many were written or at least inspired by Cavour. The 1844 volume is particularly rich in descriptions of natural and artificial fertilizers and their use. The object of special interest was guano (first imported in large quantities by England in 1835 for distribution to all Europe[9]), which Cavour was eager to use as soon as possible on his farms in the Vercellese area.

The firm Gaston-Foy de la Tour et Compagnie, Marseilles and London, was a large importer, and a long article publicizing guano in the September 13, 1844 edition of the *Gazzetta* was preceded by the following editorial:

> The firm Gaston-Foy de la Tour et Compagnie, Marseilles and London, stated in its letter of August 3, addressed to Cav. Bonafous and kindly forwarded by him to the editors, that it was the first commercial firm to make considerable imports of guano for the southern departments. It offers to deliver guano in barrels of 22 cwt. at 200 francs each to the ports of Genoa and Nice. To this letter is appended an analysis of guano carried out by respected French chemists. The letter also provides directions for the use of the fertilizer for the benefit of the readers of our *Gazzetta.*

The same issue of the *Gazzetta* contains an article on guano extracted from the Bibliothèque Universelle of Geneva and includes seven analyses of guano from different origins. These indicated that the African guano was much more subject to the decomposing influence of water

[8] The *Gazzetta* was the technical organ of the Associazione Agraria Subalpina. The first number is dated May 31, 1842 (the royal patents for the institution of the association are dated August 25, 1842). After the proclamation of the "Statuto" (the first constitution of the state in 1848), the *Gazzetta* changed from a weekly to a monthly, and, with the acquisition of political liberty, the association lost its political function and concentrated on the technical section for agricultural progress.

[9] Charles Singer, E. J. Holmyard, A. R. Hall, and Trevor I. Williams (eds.), *A History of Technology* (5 vols.; Oxford, 1954–58), IV, 254.

and air than its Peruvian counterpart and that its uric-acid content was less. On the other hand, the Chilean guano was purely a phosphatic fertilizer.

* * *

Knowing from his own experience that the development of agriculture was an economic necessity, and nurtured by reading and by news from abroad, Cavour's move toward the use of chemical fertilizers was quite natural. Eventually, he started a fertilizer factory that ultimately freed Piedmont farmers from the necessity of buying fertilizer from outside the kingdom of Piedmont-Sardinia.

Only recently had chemistry become scientific in its methods and approach. During the Industrial Revolution in England some intimation of forthcoming changes had become apparent, noticeable even in Piedmont. But at that time, the chemical industry of the Sardinian state was little more than an infant. Nevertheless, an early attempt was made to manufacture two important chemicals: sulfuric acid and phosphorous.

The production of sulfuric acid developed empirically. Even in the middle of the eighteenth century, before the existence of a true chemical industry, sulfuric acid was used to some extent in metallurgy and, later, in the textile industry and in candy-processing. The increasing demand for sulfuric acid could be satisfied through the substitution of lead chambers for the glass and refractory vessels generally used before. The first lead-chamber plants were introduced in England around 1750. Not until thirty years later did Piedmont follow this development, finally stimulated by the availability of minerals such as pyrites (ferrous sulfide) at Brosso near Ivrea, and from the growth of the textile industry with its demand for colors and mordants.

Two early concessions (dated June 26, 1781 and July 18, 1783, Archivio di Stato, Turin) were granted by King Victor Amadeus III to Francesco Cumino, a major in the infantry, "to favor the valleys of Brosso, Pont, and Chy," whose rich mines of pyrite could be exploited for the production of "vitriol, oil, spirit of vitriol, strong water, rock alum, and other minerals necessary for making dyes and other objects of art."

On April 8, 1815, King Victor Emmanuel I renewed the patents of Cumino's successor, attorney Carlo Ballauri. The factory, however, was not able to meet the demands of the market, and on January 25, 1816, Saverio Paris of Châteauneuf, Franche-Comté, obtained a concession and exemptions from the king for himself and his friends, Sclopis and Carignani. Although they were already producing sulfuric acid in the Reaglie region on the outskirts of Turin, they wished to

establish a new factory for the manufacture of sulfuric acid, alum, and ferrous sulfide in the Maddalene region outside Porta Palazzo. These privileges were granted on the basis of an expert's report requested by the Council of Commerce, whose head underwriter was Giovanni Giobert.[10]

On April 30, 1816, Victor Emmanuel granted a wide concession to Sclopis and Carignani with the condition that all rights formerly granted to Ballauri be explicitly maintained, "without any prejudice to the already established factories at Brosso, Pont, and Chy." Owing to the success of Sclopis and Carignani, the firm of Ballauri was forced in 1830 to request a continuation of the privileges for their factories in Brosso; it was granted, but the Ballauri firm remained unsuccessful.

Although the Sclopis and Carignani firm had become the most important producer of sulfuric acid, the renewal of its concession was refused on April 28, 1830, because its selling prices were too high and its business procedure almost monopolistic. This paved the way for new competition. Between 1830 and 1831, the Ministry of Finance granted to the corporate chemist-druggists Giuseppe Viviani and Giovanni Battista Schiapparelli the right to import, duty free, materials and apparatus essential for the factory they intended building near Turin.[11]

[10] Archivio di Stato, Turin, Economic Matters–Commerce, Category 4, Chemistry, additional group 4. Among these interesting papers regarding the beginnings of the chemical industry in Piedmont is a comprehensive report dated January 23, 1816, which refers particularly to Emanuele Filiberto, 1570, and to the edicts of the eighteenth century, concerning sulfuric acid and oil of vitriol–green vitriol or ferrous sulphate-rock alum. The report is signed by "Ghiliossi," prominent in the late eighteenth and early nineteenth centuries. He never stopped being a "personage," passing safely through the French Revolution, the Napoleonic era, and the Restoration. The report suggests that the decision of this very influential person to grant the requested privilege was aprioristic, and even the appeal to the Accademia delle Scienze seems to have been *pro forma*. In the academy's technical report, the scientific commission, composed of Giobert, Michelotti, Carena, and Bernardo Alessio Rossi, complains of the lack of time given to establish whether the products presented to them had been actually manufactured by the petitioners in their own factories and to ascertain on the spot the methods of manufacturing. Although the commission refused to comment on the concession of the privilege, the requests of Paris, Sclopis, and Carignani were accepted, and the patent repeats, almost word for word, what Ghiliossi had written in his report. The reports of Ghiliossi and of the Accademia delle Scienze and the patents are published in my book, *Camillo Cavour e l'industria chimica dei concimi* (Turin, 1964), pp. 57–82.

[11] Archivio di Stato (see n. 10). The factory intended producing sulfuric acid, green vitriol, rock alum, magnesium sulfate–Sclopis and Carignani had already received the concession to produce these products, as well as muriatic acid, artificial soda, and others. The petitioners declared that they were adopting quite new proce-

In the same year, 1831, a factory producing calcium chloride and, later, bone charcoal and ammoniacal salts began operations near Porta Palazzo. Head of this factory was Bernardo Alessio Rossi (who would become an active participant in the future Cavour factory), who transferred the plant to Lingotto, where it produced sulfate and carbonate of magnesium and for which it received a silver medal at the exposition at Turin in 1838.

The initiative of the Piedmont chemical industry in producing sulfuric acid was now rewarded by the manifold uses of the chemical and by a logical development of its by-products. Production costs were perceptibly lowered. Even on a modest scale it was beginning to emulate its better-known counterparts across the Alps. It is worth noting the characteristics of the chemical industry in England at its very beginning:

> The works of the chemical manufacturer tended to become larger and more complicated; he began making soda, using common salt and sulphuric acid and other raw materials. After a time he started to make his own sulphuric acid by burning sulphur or pyrites; if he used pyrites, it was probably a mixed sulphide of copper and iron, and it was comparatively easy to make copper sulphate and ferrous sulphate from the roasted pyrites. The process of making sodium sulphate produced large quantities of hydrochloric acid, and, as nitric acid was required in the manufacture of sulphuric acid, the alkali manufacturer easily developed into a manufacturer of hydrochloric, nitric, and sulphuric acids, and various salts of sodium, copper, and iron. It was a very common development for the alkali manufacturer to use the chlorine he recovered so as to make bleaching-powder, and in this way he became a maker of calcium chloride and bleaching-powder, and, as demands for them grew, he made other salts of sodium and calcium required in large quantities. The manufacture of all these "heavy" chemicals became in this way an involved process, in which one part was dependent on the others and almost every effort to prevent waste involved the manufacturer in some new product.[12]

---

dures they had studied in French factories. Viviani and Schiapparelli also succeeded in obtaining permission to import duty free 6,000 *rubbi* (1 *rubbo* = ca. 10 kg.) of laminated rolled lead, a platinum boiler, some copper steam boilers, and a number of cylinders of pig iron—each item necessary for the production of sulfuric, muriatic, and nitric acids. Platinum had been used only recently for manufacturing vessels for concentrated sulfuric acid. It is possible that the platinum boiler was a novelty for the Piedmont industry.

[12] Quoted from Stephen Miall, "History of the British Chemical Industry," in Singer *et al.* (eds.), IV, 242.

Although starting about half a century later, the modest Piedmont factories adopted the same trend in the development of their products. Nonetheless, they were working under conditions so poor as to merit harsh criticism from Ascanio Sobrero, the discoverer of nitroglycerine, in his report on the chemical section of the 1844 Exposition of Industry in Turin. Sobrero complained about the lack of capital and men for the rising industry and also about the insufficient support given to teachers, schools, and museums by the public authorities. "We must be grateful to our manufacturers for what they have been able to do rather than wonder at their failures."[13] The main representative of the chemical industry was Ignazio Sclopis, the heir to the firm Sclopis e Carignani, who exhibited many compositions of sulfur from his mines at Brosso.

Producers of phosphorous were also represented at the Turin exposition, although the industry was relatively new. Only at the end of the eighteenth century had it been demonstrated that phosphorous was the main constitutent of animal bones. Since then, a method had been developed for treating the ashes of bones with sulfuric acid. The manufacture of matches using phosphorus had expanded in Europe during the first half of the nineteenth century, and this was evident at the exposition, where five manufacturers of phosphorous matches exhibited. Among these was Domenico Schiapparelli, the second major participant in the forthcoming Cavour factory.

* * *

Such was the very bleak situation when Cavour initiated his enterprise. At that time a factory owned by Rossi at Lingotto[14] had been producing, among other chemicals, sulfuric acid, calcium chloride, animal coal, and salts of ammonium, for which it had been awarded silver medals at the Expositions of 1838 and 1844.[15] Another factory belonging to Domenico Schiapparelli at Regio Parco[16] produced, in addition to sulfuric acid and several salts, ammonia from illuminating gas, water, and phosphorous. In spite of its very recent formation, this factory also received a silver medal at the 1844 exposition.[17]

Cavour proposed merging the two factories in order to utilize the residue of these commonly used chemicals for fertilizer production.

[13] Carlo Ignazio Giulio (comp.), *1844 Quarta Esposizione d'Industria e di Belle Arti al Real Valentino: Giudizio della Regia Camera di Agricoltura e di Commercio di Torino e Notizie sulla Patria Industria* (Turin, 1844), pp. 117–19.

[14] Suburban area south of Turin.

[15] Giulio, p. 122.

[16] Suburban area north of Turin.

[17] Giulio, p. 124.

He then informed De la Rue[18] of his intention to create a company of four partners: Rossi and Domenico Schiapparelli, whose talents Cavour admired; Pietro Di Santa Rosa, another friend; and himself. Prior to this, however, in February 1847, Cavour had sent Corio samples of a fertilizer prepared by Schiapparelli to be tested in Leri. "As the question of establishing a fertilizer factory in Turin has come up, I wish this test to be scrupulous and exact. The purpose of the test is to evaluate the effects of this new fertilizer as compared to guano."[19]

The company was formed on May 25, 1847 with a capital investment of 50,000 francs, about $80,000 today. A document signed by Cavour, Rossi, and Schiapparelli simply stated that a *società in accomandita* had been formed to manufacture general chemicals for a period of nine years. Cavour was a silent partner, while Rossi and Schiapparelli were the managers.[20] The building at Lingotto, owned by Rossi, was sold[21] to the future Società Rossi e Schiapparelli for 74,000 lire, cash. Schiapparelli represented the new firm as buyer of the building which was afterward converted to the new manufacturing process.

From the very beginning, Cavour's enterprise was successful in manufacturing ordinary chemicals, but the success of fertilizer production was in doubt. Cavour approached the problem realistically in his letters to Corio and De la Rue and considered fertilizer manufacturing to be purely experimental. What then was the theoretical and practical information on hand that could have been of assistance to Cavour?

Seven letters to William de la Rive, 21-year-old son of Cavour's great friend, Auguste, of Geneva, answer this question. These letters, dated between January 20 and September 6, 1847, were published by Luigi Chiala.[22] William had been sent by his father to Edinburgh to study agriculture, which, at that time, was flourishing in Scotland. There he entered the laboratory of James F. W. Johnston, who taught chemistry

[18] Cavour's letters indicate that De la Rue was not enthusiastic about the count's new enterprises. Reciprocal letters of De la Rue to Cavour are at the archives of the Fondazione Cavour in Santena. Their publication would be of profound interest.

[19] Cavour to Corio, Leri, February 1847, *Cavour agricoltore,* letter 35.

[20] Unedited, Archivio di Stato, Turin, United Sections–Deeds of the Count of Turin, "Società" (1846–47).

[21] Unedited, Archivio di Stato, Turin, United Sections–Deeds of the Notary Orazio Cassinis (1847), Vol. LI, No. 61, Paper 61. Both documents mentioned in nn. 20 and 21 are published in my above-mentioned book, *Camillo Cavour e l'industria chimica dei concimi,* pp. 85, 87–89.

[22] Luigi Chiala (ed.), *C. Cavour: Lettere edite e inedite* (6 vols.; Turin, 1883–87), Vol. IV, Nos. 1249–53. It would be desirable to have these letters and others from De la Rive republished in their entirety, together with reciprocal ones as yet unknown.

and mineralogy and whose book, *Catechism of Agricultural Chemistry*, was widely used throughout England and Europe. Cavour had introduced the book to the Associazione Agraria Subalpina, where Count Avogadro di Casanova had offered a prize (1847) for the translation of the book with special reference to the situation in Piedmont. Cavour considered Johnston to be "the most distinguished agricultural chemist in Europe."

Young William, already interested in Cavour's problems regarding fertilization, answered from Edinburgh his questions about the effects of sodium chloride in the soil on the cultivation of rice and also analyzed the soil from Cavour's asparagus farm at Santena.[23] Cavour wished to interest his young cousin in his main concern of the moment—the chemical factory. In a letter to William, written only 18 days before the formation of the Società Rossi e Schiapparelli, he wrote:

> Maintenant que vous avez consenti à un premier travail, je viens vous demander un nouveau service, auquel j'attache un prix encore plus considérable. Voici de ce dont il s'agit. Voiyant le succès prodigieux que le guano obtenait auprès de nos agriculteurs, je me suis dit que le pays était *mûr* pour une fabrique d'engrais sur une vaste échelle. Notre plan est celui-ci.
>
> Nous avons établi une vaste fabrique d'acide sulphurique, ensuite une fabrique de phosphore; enfin nous fabriquons plusieurs articles qui sont très demandés dans le pays: les sulphates de fer et de cuivre; le sulphate de magnésie; le carbonate de soude, etc. Tous ces produits nous laissent beaucoup de résidus que nous voudrions combiner avec des débris animaux: le sang, les cornes, etc., les eaux du gas et peut-être les matières fécales. Nous sommes montés sur une grande échelle, les capitaux ne nous manquent pas de sorte que nous réunissons beaucoup d'éléments de succès. Mes collaborateurs sont fort intelligents, un surtout possède une grande habileté jointe à des connaissances assez étendues; il a monté une fabrique de phosphore qui marche admirablement bien, mais pour ce qui regarde les engrais artificiels nous n'avons à nous trois que des connaissances fort imparfaites. Nous avons à notre disposition des phosphates, des alcalis et des sels ammoniacaux; mais nous ne sommes pas encore fixés sur la manière de les employer, ou pour mieux dire, de les combiner ensemble.

[23] Asparagus was, and still is today, a traditional crop of Santena, which is about 20 km. from Turin. Santena is the site of the feudal possessions of the Cavour family, the chapel-tomb of Camillo Cavour and his relatives, and a Cavourian museum; it is also the seat of the Camillo Cavour foundation. This property and a splendid eighteenth-century villa of the Cavour family, surrounded by wide meadows, trees and farmlands, was given, not many years ago, to the municipality of Turin as a center of Cavourian studies and research, by the last heirs of Cavour.

> A cet égard il a été fait beaucoup de travaux en Angleterre. Si je [ne] me trompe, il y a à Glascow une grande fabrique de produits chimiques et d'engrais. Il vous sera facile de connaître ce qu'on y fait. Les renseignements que vous pourriez recueillir à ce sujet me seraient excessivement précieux. L'engrais c'est la base de l'agriculture. Si on ne peut s'en procurer, on est arrêté dans la carrière du progrès et l'édifice qu'on veut élever, pêche par la base. C'est donc en quelque sort de vous que dépendent les succès de l'œuvre que j'ai enterprise; votre appui, je l'espère, ne me fera pas défaut.

This may have been too heavy a burden for the shoulders of young William, apprehensive of the immense faith evident in Cavour's letters. Moreover, William doubted the contribution of chemistry to agriculture. In his brilliant biography of Cavour, published only a few months after the count's death, William discusses the above-mentioned correspondence and adds his own opinion thereupon, as follows:

> "Là, comme en toutes choses, la pratique excitait chez lui, loin de l'étouffer, l'esprit de recherche et d'investigation; peut-être péchait-il même par excès de confiance, et la nature des questions qu'il m'addressait et que j'ai rapportées, semble révéler des espérances qui ne se sont pas réalisées. On sait que la chimie agricole, si encensée il y a vingt ans, aujourd'hui un peu délaissée, a perdu de son prestige et j'ajouterai à juste titre; le temps n'est plus où l'analyse apparaissait comme la clef magique de tous les problèmes agricoles."[24]

In support of his arguments, William points to the suppression of Johnston's laboratory.

Nonetheless, Cavour, not William, was right. Perceiving that the study of the composition of the soil was necessary to determine the most suitable fertilizer for each soil and crop, Cavour recommended controlled experimentation. In fact, Cavour's faith in agrarian chemistry applied to the trinomial, soil-crop fertilizer has been justified by the surprising results that this practice gave and continues to give. Furthermore, the importance of such research is confirmed by the establishment of laboratories in large fertilizer factories so farmers can learn about their soils and crops and choose the right kind of fertilizer.

The problem of artificial fertilization is still not solved. The difficulty that faces experts today is the same as in Cavour's time: the exact proportion of the three fundamental elements—nitrogen, phosphorus, and potassium—for each type of soil. The problem is compounded by many interdependent factors, and the solution has to be laboriously

[24] William de la Rive, *Le Comte de Cavour—récits et souvenirs* (Paris, 1862), p. 86.

calculated through long series of statistical data. Today, electronic computers are used for solving such problems.[25] The growing attention to soil analysis gives evidence of Cavour's foresight in applying chemistry to agriculture.

Since both he and the company lacked knowledge of and had no direct experience with chemical fertilizers, Cavour wished to put at its disposal all that he had conscientiously learned from foreign books on agrarian chemistry. Among those known to Cavour were books by James F. W. Johnston, Jean-Baptiste Boussingault,[26] Henry Stephens,[27] and Justus von Liebig.[28] Many other books and magazines, listed by Giuseppe Prato,[29] and treating of the problems by agrarian chemistry, were quoted in the *Gazzetta dell'Associazione Agraria Subalpina.*

The theories of Liebig opened the way to a scientific study of fertilizers and their experimental application. But it was the practice in England that was especially meaningful to Cavour:

> Soap-boilers' waste and tailors' shreds were two industrial by-products pressed into service. Peat ashes were burned near Newbury and sent to other districts. Stable and cow-shed manure was collected in towns and carried by barge or cart to farms within reach. Towards the end of the eighteenth century cutlers' waste from Sheffield began to be used in the neighbouring countryside: this consisted of scraps of horn and bone resulting from the manufacture of knife handles and so on. The good effects of this material on pasture were readily observable, and a large demand for

[25] Gianni Russo, "Indagini statistiche di mercato e 'selezioni incrociate' eseguito con un elaboratore elettronico Gamma ET a tamburo magnetico" (paper presented at the 6th Meeting and Exhibition of Automation and Instrumentation, Milan, November 7–12, 1961).

[26] Boussingault was then professor of Agriculture at the Conservatoire des Arts et Métiers in Paris and had written *Traité d'économie rurale* in two volumes highly esteemed by Cavour. De la Rive went from the Scottish laboratory of Johnston to that of Boussingault in Paris in 1847.

[27] Henry Stephens' main work, *La Ferme* (1844), in eight volumes, is quoted in Cavour's letter to De la Rive on August 20, 1847. "J'ai reçu Stephens," Cavour wrote; "je lis avec assiduité pour être en mesure de ne pas trop rougir quand je me trouverai au milieu de vos savants amis" (Chiala (ed.), Vol. V, No. 1252).

[28] Liebig had propounded his static theory about the nutrition of plants, concluding that it was necessary to restore to the soil through fertilizers the chemical elements absorbed by previous plantings, thus retaining soil fertility.

[29] Giuseppe Prato, *Fatti e dottrine economiche alla vigilia del 1848: L'Associazione Agraria Subalpina e Camillo Cavour* (Turin, 1920), pp. 46–48; extract from the *Biblioteca di storia italiana recente* of the "Regia Deputazione sovra gli studi di storia patria per le antiche province e la Lombardia," Vol. IX.

> crushed bone arose. Some farmers installed grinding machinery; others bought the material ready crushed. Later, bones were dissolved in sulphuric acid and demand for the product became so great that the battlefields of Europe are said to have been searched for material. Late in the 1820's, the first cargo of Peruvian guano arrived, to be followed not much later by shipments of Chilean nitrate. These were extensively used by the British farmers during the following decades. When Sir John Bennet Lawes (1814–1900) began to manufacture calcium superphosphate in 1842 the artificial fertilizer industry may be said to have been established.[30]

The development of calcium superphosphate fertilizer brings us to the product planned by Cavour for the new Rossi-Schiapparelli factory. Since the first phases of manufacturing superphosphates are identical to those of phosphorous, and since Cavour appreciated the phosphorous that Schiapparelli produced at his factory,[31] it was quite natural that he became the first manufacturer of superphosphates. Following current practice, the phosphorus from bones was treated with sulfuric acid, making a solute for distribution over the soil. As early as 1808, experiments near Belfast had been carried out with very good results. Liebig himself had recommenced experimenting in 1840. But the first manufacturer on a commercial scale was Sir James Murray (1788–1871), a Dublin physician, who had conducted his earliest experiments about 1817. He also demonstrated that superphosphates could be made not only from bones but from mineral phosphate rock, and he was actively producing mixed fertilizers containing superphosphate, guano, and Chilean nitrate.

Murray's method of manufacturing superphosphate, patented in 1842, consisted of combining mineral phosphate with an equal weight of sulfuric acid in an earthenware vessel and agitating the mixture thoroughly for 2 or 3 days. After this, it was mixed with some absorbent material, such as bran or sawdust. This yielded a dry, powdery fertilizer, easy to handle, which was sold in 280-lb. casks.[32]

We have now reached an interesting point in this research, as Murray, in 1844, requested permission from the Sardinian government to

[30] Singer *et al.* (eds.), IV, 20. No item in this list is wanting in Cavour's letters to Corio. The English derivation of Cavour's experiments is obvious and references to England abundant in these letters. Significant is the point made to Corio in Cavour's of March 5, 1846, *Cavour agricoltore*, letter 2, suggesting the use of rags dissolved in the water residue of gases: "It would be quite a new thing and *not even tried in England*" (italics mine).

[31] Cavour to De la Rue, Turin, March 22, 1847, in Bert (ed.), letter 70.

[32] Singer *et al.* (eds.), V, 254.

introduce his methods into the kingdom. Just as interesting is the conscientious and thorough investigation carried out by the Sardinian government on his behalf.

Piedmont farmers, bound to their land by tradition, were known for their competence in agriculture yet remained almost untouched by scientific progress, treating theories with some diffidence. Although bones had been used widely for fertilizer for some time, Piedmont authorities were cautious in accepting novelties and were rightly skeptical of the miraculous powders for which, every so often, patents were sought. A typical example was the patent application presented in 1827 by Doret-Valette-Sacirere[33] for a fertilizing meal patented in Germany and extensively illustrated in a printed pamphlet. This publication emphasized the presence of bones together with an undefined substance called "Zusatz." In a harsh report signed by Giobert, the committee of the Associazione Agraria Subalpina found the product to be of no value, being "mere bones with little earth."

Quite different, however, was the reaction to the subsequent patent application made by Murray. Both the committee of the Reale Accademia di Agricoltura and that of the Regia Camera di Agricoltura e di Commercio di Torino were favorable toward Murray's request, although somewhat reserved.

Murray's request was strengthened by the three patents he had already obtained in England for the improvement of fertilizers, in which he claimed to have first introduced "a method to convert the earth of mineral bones, or apatite, to superphosphate of calcium soluble for the soil." He further claimed to have obtained "a new composition in which a reasonable proportion of nitrogen was retained by means of the correct addition and decomposition of crushed animal bones (principally the albumen found in the bones) together with mineral calcium phosphate."

Murray therefore asked for the sole right to manufacture his new fertilizer for 15 years, which, in his opinion, should be advantageous to the Piedmont economy:

—because it would correct the deficiencies in the Piedmont soil lacking animal and phosphate qualities,
—because it would utilize bones then being wasted,
—because in the dry earth of Piedmont, a more soluble process of mixing these elements with the soil is necessary since both animal bones and mineral bones in the earth do not decompose "in the hot season nor in the heights."

[33] Archivio di Stato, Turin, Economic Matters—Commerce, Category 4, Chemistry, additional group 4.

The response of the committee of the Reale Accademia was cautious. They contested Murray's argument that the Piedmontese soil was deficient, for they claimed that Murray had not tested it adequately; they also contested the fact that animal bones were not being used. As to the chemical transformation in the soil, they denied the necessity of making phosphate of calcium soluble before applying it to the soil; finally, they doubted the possibility of a free acid existing in the presence of a basic phosphate, since free acids, with the exception of carbonic acid, harm vegetation, as well as delay the decomposition of fertilizers.

That the committee granted a 4-year privilege (later increased to 6 years after discussing the report in the plenum of the academy) was not proof, however, of their faith in the fertilizer. It was granted because the manufacture of the fertilizer "neither requires costly equipment nor is the first installation to expensive" and because "a short-term privilege cannot be harmful to the agricultural industry of this country but rather [will] develop and consolidate it when its usefulness is recognized."

More benevolent was the proposition of the Regia Camera di Agricoltura e di Commercio di Torino, later formally questioned by the government, to extend the privilege to 8 years upon the condition "that it must be clearly established that the privilege be strictly limited to the manufacturing of a fertilizer composed of apatite, bones and sulfuric acid, although bones, either whole or crushed, must remain at the disposal of everyone as before." Besides this, the Camera di Agricoltura seems to have supported Murray's theory of the need for rendering animal bones soluble because of Piedmont's dry earth. But even this second report showed reserve when considering Murray's scientific conceptions. "We do not intend to discuss the chemical and agricultural theories of Mr. Murray, although we believe that he ascribes to the phosphates a much more powerful action than they really deserve and that he is mistaken when he says that sulfate of calcium has the power to fix the ammonium from the atmosphere. We shall limit ourselves to saying that, although it is possible to accuse Mr. Murray of exaggeration, his fertilizer undoubtedly will, in numerous cases, have very good effects."

Murray's patent application indirectly gives us an insight into the affairs of the Cavour's factory. He explains "that to induce the brothers Sclopis and other esteemed persons to procure the necessary apparatus and foundries, and to give them time to be compensated for the large outlay of capital, it is indispensable to have a clear and perfect privilege of 15 years during which time no one else in these states might make

use of animal bones or manure of mineral bones for the said purposes, thereby harming the petitioner."

This means that Murray had contacted Sclopis, who owned the most important chemical products factory at that time, in order to grant the Italian a license for manufacturing superphosphate according to his method. It was Sclopis who wanted the sole rights of production in Piedmont for 15 years.[34]

But the Murray affair went no further. Was it because of the reduction of the concession from 15 to 8 years? Or did Murray get angry at the rather severe criticisms made by the government technical commissions? Or was there a gentleman's agreement among Sclopis, Cavour, and Murray to stop production of the latter's fertilizer in Piedmont? Whatever it was, Murray's superphosphate was not manufactured in Piedmont. Yet, 2 years later, Cavour opened the Società Rossi e Schiapparelli without Murray or Sclopis and without any patent. The Schiapparelli fertilizer, which had already been sampled, must have been very similar to Murray's. Both were marketed under the name of *guano artificiale;* both tried to obtain through chemical combinations or mixtures a composition as near as possible to that of natural guano or, precisely, Peruvian guano. Murray"s product, however, started from phosphoric mineral–apatite–while that of Rossi e Schiapparelli very likely started from animal bones. Schiapparelli's product was probably one of those fertilizers called "mixed" (not to be confused with those called "complex") where other elements, mainly nitrous organic material (blood and various salts), were added to the superphosphate of whole or crushed bones.[35]

[34] Murray's demand, his secret explanations, and the reports, both of the Accademia delle Scienze and of the Camera di Agricoltura e di Commercio, are in the Archivio di Stato, Turin, Economic Matters–Commerce, Category 5, Privilegi, group 7, and are published *in extenso* in my book *Camillo Cavour e l'industria chimica dei concimi,* pp. 91–111.

[35] It is possible that the great Italian concern Montecatini is the natural heir of the first timid attempts to foster chemistry. The vice-president of the firm, Luigi Morandi, acquainted with my research, showed personal interest in my effort to find out whether some connection could be made between the "Schiapparelli fertilizer" and that being produced today. No direct document could be found. The only source of information that Montecatini could offer was in the biography of Cavour by De la Rive. Nothing new was concluded therefore. One interesting thing was clear, however. From the Cavourian experience in superphosphate manufacture together with that of an animal glue particularly developed in Turin resulted the traditional Piedmont preparation–superphosphate or "Ruffetto"–which, together with sulfuric acid from Montecatini, was used mainly in the province of Alessandria and in Bra until World War I.

Both the English and Italian initiative in fertilizer production suffered adverse fortune. Trevor I. Williams says that Murray, although first in this field, was not able to make a success of his venture.[36] Murray's failure must have been essentially a commercial one, since from a technical point of view his fertilizer was an important innovation.

The first to succeed commercially was John Bennet Lawes, 26 years younger than Murray, who began making extensive agricultural tests on his own estate at Rothamsted when only 20 years old. With youthful energy and a good head for business, Lawes exploited Murray's experience. He was not yet 30 when he established his large superphosphate factory near London in 1843, yet by 1870 his output was about 40,000 tons annually.

Even Schiapparelli's fertilizer was not a success. It was used on the Cavour farms at Leri at Cavour's insistence. But Corio was impatient. The superiority of guano was so evident that Corio did not want to hear of the Schiapparelli fertilizer, which wasted both time and money.[37]

The same point of view was shared by the juries at the Turin exposition. Although Rossi e Schiapparelli received a gold medal for its regular products in 1850, the jury had treated the "artificial guano" with reserve. It deeply regretted not being able to give the fertilizer a positive judgment after having highly praised the other products—mainly phosphorous, soaps, and stearic candles—but concluded that, with experimenting, the artificial fertilizer might confirm the hopes of the inventors.

The Rossi e Schiapparelli firm seems to have prospered in basic chemical products. Yet the cautious banker, De la Rue, had always been against financing it. Instead, he preferred buying and reselling guano at a good profit with Cavour helping Rossi e Schiapparelli. Toward the end of 1851, the ship *Victoria* arrived with a load of 155,722 kg. of Peruvian guano which had been ordered directly by Cavour in association with De la Rue.[38] Peruvian guano was, at least momentarily, the real winner.

Before the termination of its 9-year contract the Rossi e Schiapparelli firm was liquidated by a private agreement (February 14, 1855) returning the following shares to each partner: 10/21 to Cavour; 7/21

[36] Singer *et al.* (eds.), V, 254.

[37] Corio to Cavour, 1851, Archivio Cavour, Santena (Turin), unedited letters. With the kind permission of Maria Avetta, director of the Archivio Cavour in Santena, I was able to examine some two hundred unedited letters from Corio to Cavour, covering the decade 1846–56, which happily complete the collection of those written by Cavour to Corio during the same period.

[38] Cavour to Corio, December 1851, *Cavour agricoltore*, letter 167.

to druggist Rossi; and 4/21 to Schiapparelli. A few days later (February 20, 1855), Schiapparelli divided his own shares 10/17 to Cavour and 7/17 to Rossi. Finally, in a document dated December 24, 1856, Cavour and Rossi sold "the factory and the neighboring ground formerly used for the purpose of manufacturing chemicals" to the Società Anonima di Assicurazione contra la Mortalità del Bestiame ed Utilizzazione delle Bestie Morte.[39]

At the next industrial exposition (1858), both the old companies—Rossi in drugs and Schiapparelli in phosphorus and nitrous fertilizers—were again operating independently. By this time the industry had grown to the point where four manufacturers exhibited the so-called *guano artificiale*.[40]

* * *

Today, reserves of guano are practically exhausted, and bones have been replaced by phosphatic minerals,[41] particularly phosphorites,[42] ex-

[39] Catasto–Registro Stralcio, Atti del 1855, Archivio Comunale, Turin.

[40] There were four producers of *guano artificiale:* (*a*) The Società Anonima dell'Ecarissage, Turin, with a factory at Lingotto, was awarded the bronze medal. It exhibited samples of artificial guano whose quality had already been confirmed through experience. The components of this guano are mainly animals dead from illness, and blood from the butcheries. It contained about 70 per cent fertilizing material and was efficient for all crops. The quantity required for good fertilization amounted to 13 *miriagrammi* for each *giornata* of land (3,800 sq. m.), and it was sold in Turin for 17.75 lire per 100 kg. (No doubt this company had its origin in the Società Anonima d'Assicurazione contra la Mortalità del Bestiame ed Utilizzazione delle Bestie Morte, already mentioned as the buyer of the real estate of the late Società Rossi e Schiapparelli.) (*b*) Schiapparelli Domenico e Compagnia, Turin, awarded a silver medal for its chemical products, exhibited some sample of its artificial fertilizer, called "Guano Dorina." (*c*) La Vespasiana was a factory for *guano ligure* in Sestri Ponente (Genoa). (*d*) Musso e Compagni in Novara. This information is taken from the *Album descrittivo dei principali oggetti esposti nel Real Castello del Valentino, in occasione della Sesta Esposizione Nazionale dei prodotti d'industria, nell'anno 1858*, l'Ufficio Speciale dei Brevetti d'invenzione diretto da G. Capuccio ingegnere e M. Latini (Turin, 1858). Nothing is specified about the last two companies. The successor then of the Società Rossi e Schiapparelli seems to be the Società dell'Ecarrisage, which continued the production of artificial guano. La Società dell'Ecarissage will later become the Società Colla e Concimi (glue and fertilizers); see n. 35. It is the first producer of Ruffetto (superphosphate of bones), the fertilizer whose manufacturing became traditionally rooted in the zones of Alessandria and Bra.

[41] Società per lo Sviluppo dei Consumi dei Fertilizzanti (SEIFA), "I Concimi Chimici in Italia," *Edagricole* (Bologna, 1960).

[42] Phosphorite is a mineral, chemically a tricalcium phosphate associated with calcium carbonate. Soluble in acids, it serves as the base of the mass production of calcium perphosphate (or super phosphate) through attack from sulfuric acid,

tremely rich deposits of which were discovered in North Africa toward the end of the nineteenth century. Cavour's hunger for fertilizers would have been easily appeased. He would not have had to purchase overseas guano by the shipload nor have had to find large quantities of bones. He undoubtedly would have approved of the new complex fertilizers, the consumption of which dizzily increased from 2,000,000 to almost 9,000,000 quintals during the years 1955–59. Twenty-three per cent of azote, thirty-nine per cent of the phosphoric anhydride, and fifty-nine per cent of the potassium oxide are distributed throughout Italy in nitrous, phosphatic, and potassic fertilizers.[43]

It is quite right to assume that the *guano artificiale* Cavour was looking for was exactly that chemical fertilizer which should contain, in right proportion (even though he was not completely aware of it), the three basic elements that encourage vegetative process–azote, phosphorus, and potassium.

The Schiapparelli fertilizer was the first sign in Italy of the large modern industry of perphosphatic fertilizers, containing from 10 to 20 per cent of phosphoric anhydride (P_2O_5). Cavour readily ran all risks without wavering. He clearly saw that the phosphatic was the only fertilizer that could then be manufactured with the raw materials–bones and sulfuric acid–at his disposal.

Cavour had always been proud of his initiative, but on one occasion he had to defend his participation in the firm Rossi e Schiapparelli. During a session in the House of Deputies on June 28, 1851 as minister of agriculture, he was obliged to answer the insinuations of a deputy concerning the connection between his personal interests and the new

---

through the main reaction: Phosphorite (tricalcium phosphate) + sulphuric acid → perphosphate (monocalcium phosphate) + calcium phosphate (ballast).

[43] SEIFA's last publication, *I mezzi tecnici nell'agricoltura Italiana–evoluzione dei consumi dal 1953 al 1960* (Bologna, 1962), confirms the trend also for 1960. The general trends of production and consumption of chemical fertilizers in Italy find a further confirmation in the more recent statistics of the Instituto Centrale di Statistica in Rome, which has documented the solid increase in production. The *Monthly Bulletin of Statistics* for December 1963 registers the following data of chemical fertilizer production during 1961, 1962, and the first 9 months of 1963 (in quintals):

Fertilizers	1961	1962	1963 (9 Months)
Phosphatic	16,776,260	15,644,310	11,825,610
Nitrous	28,327,140	27,725,720	20,558,190
Potassic	1,749,300	2,235,670	1,836,560
Complex	11,188,820	13,864,403	11,147,410

tariff. We can believe Cavour when he wrote to De la Rive saying that he had strong shares in a chemical fertilizer factory: "dans un but d'utilité publique plus encore que comme spéculation privée."[44]

The production of chemical fertilizers in Italy today has assumed vital importance. Their extraordinary impact on agricultural progress has convinced Italian farmers of their necessity. But let us not forget the first steps, uncertain and wearisome! And there, once more, is Cavour, farseeing, courageous, and dynamic, and Piedmont, slowgoing, but serious and conclusive. Piedmont produced Cavour, and Cavour awakened Piedmont. His initiative in fertilizer production and use, as in politics, was another link in that chain of actions and reactions from which the modern nation of Italy arose.

[44] Cavour to De la Rive, September 6, 1847, in Chiala (ed.), Vol. V, No. 1253.