2. Pest Resistance in Agriculture: An Economic Perspective

URI REGEV

1. Introduction

One of the most striking trends to have taken place in the past 100 years in modern agriculture is the decrease in its economic share in developed countries, from about 50–70 to 2–4%, concomitant with the ability to supply ever rising quantities of food to the entire world. This drastic increase in food production efficiency is largely attributable to the interaction of chemical pesticides and herbicides, and the genetic selection of new high yield but susceptible plant varieties. However, this wealth of food output has cost society dear in negative side effects (externalities) that have resulted from the tremendous increase in the use of chemical pesticides. These externalities include air, soil and water pollution, residues in the food chain, elimination of beneficial organisms, disruption of the natural ecological equilibrium, and the development of pest resistance to pesticides. Ecologists were among the first to recognize the environmental consequences of extensive chemical use in modern industry and agriculture. Carson (1962) shook the world when she warned of the environmental threats posed by pesticides, and Van den Bosch’s provocative book The Pesticide Conspiracy (1978) alerted society to the economic consequences of environmental pollution and resistance to chemical pesticides: “Today the pesticide treadmill spins more wildly than ever. We use twice as much insecticide as in 1962, there are more insect species of pest status than ever before, insect control costs have skyrocketed, and insecticide impact on the environment is the worst in history” (Van den Bosch, 1978, p. 35).

The economic incentive problem associated with the external effects of pesticides is that our market prices do not reflect the benefits and cost entailed by these externalities. As a result, profit-maximizing criterion of competitive firms ignores external effects of pesticides, which results in resource misallocation by pesticide users involving the wrong choice of control strategy as well as the overuse of chemical pesticides. This phenomenon has not gone unnoticed, but was already observed some 25 years ago in quite a few studies (Hueth and Regev, 1974; Feder and Regev, 1975; Regev, 1976; Regev et al., 1976; Carlson, 1977). Note that resistance differs from other externalities of environmental pollution in that its impact (reducing future efficiency of currently used pesticides) affects the farmers themselves, rather than the rest of the society. This type of externality is known as
the common property resource problem, which is a special case of the well-known prisoners’ dilemma in game theory.

Pesticide resistance is a global phenomenon that has affected common pests including fungi, bacteria, insects, rodents, and nematodes. Since World War II, chemical pesticides have been the major weapon for suppressing human and agricultural pests. However, as early as 1950, some species began to exhibit resistance to DDT and other organochlorine compounds. After several years, resistance spread to the more expensive organophosphorus compounds. Weed resistance to herbicides developed only much later, due to the relatively slower rates of seed migration between fields, resulting in better pest control incentives (as will be explained in Section 3).

The different externalities caused by chemical pesticides have aroused conflicting reactions from individual farmers, farmers’ organizations and the chemical industry. The traditional response to pesticide environmental pollution from both farmers and the pesticide industry has been to undermine the importance of the damage and emphasize how the extensive arsenal of pesticides revolutionized agricultural technology and food production. While recognizing the limitations and problems associated with their use, they maintained that no one who comprehended the food-shortage consequences to humanity could seriously recommend that chemicals be quickly replaced by alternative means of pest control. In line with this view, LeBaron and Gressel (1982, p. 1) argued that “the net effect of pesticides as with drugs has been the same; an increasing life expectancy with medicines and an increasing food production with pesticides. Chemical pesticides must certainly be a major and increasing part of agricultural technology in the decades ahead. Resistance development is an inherent result of chemical control”.

Regarding resistance however, the incentives of the individual farmers differ from those of the pesticide industry. Resistance development is accelerated by excessive use of pesticides in pursuit of short-term gains, which entails long-term cost through permanent loss of, often irreplaceable, pesticides. While each individual farmer tends to ignore resistance in his pest control decisions, the chemical industry react differently, as Green et al. (1990, p. ix) contended: “The traditional response to resistance, by switching to new compounds, has become less practical due to substantial increases in the time and expense of agrochemical discovery and development”. Optimal resistance management could be achieved by collective action, possibly by farmers’ cooperatives who have a regional view of the problem. The economic incentives, attitudes to resistance, and the pest management policy implications of the various interest groups are further discussed in Section 3.

Any discussion of resistance would not be complete without noting the recent introduction of biotechnology that seems to present a great potential for replacing chemical pesticides in pest management. Recent breakthroughs in genetic engineering have opened the stage for dramatic changes in agriculture and, in particular, crop protection. These developments might lead to a second revolution in the