operations, the practice that is increasingly adapted by and becomes prevalent in many countries. This global trend requires other assessments beyond the economic considerations within the industry. The practice that results in the release of large quantities of antibiotics and antibiotic-resistant bacteria into other ecological compartments contributes significantly to the problem of antibiotic resistance we are facing today. The cost of the resulting resistance, which necessitates the development of new antibiotics, requires extended and costly therapy of infectious diseases and results in the higher morbidity and mortality rates, however, being taken out of the industry's economic equations.

Calls to constraint/stop the nonmedical use of antibiotics, specifically in agriculture, are issued from time to time, especially recently (Tollefson and Miller 2000; Heymann 2006; Maron et al. 2013; Meek et al. 2015; WHO 2015; Aitken et al. 2016; Jørgensen et al. 2016; UN 2016; Ludvigsson et al. 2017). The earliest attempts to ease the antibiotic selection pressure in agriculture have been made by the Scandinavian countries, in particular by Sweden, which prohibited the use of growth-promoting antibiotics in food animals as early as 1986. The measures involved the withdrawal of antibiotic growth promoters and implementation of optimal disease prevention management programs with the proper use of antimicrobials in food animal production (Bengtsson and Wierup 2006). During 1992–2008, these efforts resulted in the reduction of antimicrobial consumption by >50% and in improved productivity (Aarestrup et al. 2010). In other EU countries, specific antibiotics in feedstuffs were banned before 1 January 2006; after that date, all the growth-promoting antibiotics were deleted from the Community Register of authorized feed additives (EPC 2005; Castanon 2007). Reversal of resistance after the release of antimicrobial selective pressure, however, is not straightforward, and resistance may persist at low, but detectable, levels for many years in the absence of the corresponding drugs (Johnsen et al. 2009; Bortolaia et al. 2015). Although the occurrence of antibiotic resistance genes may be significantly reduced, they are still encountered in the absence of antibiotic selection (Kazimierczak et al. 2009; Koike et al. 2017). During a long-term selection by antibiotics, not only resistance mechanisms are selected but also compensatory mechanisms that ameliorate the fitness costs associated with resistance (Hernando-Amado et al. 2017). In this regard, a complete reversal to a susceptible phenotype is unlikely.

23.21 Conclusions

Agricultural use of antibiotics as growth promotors as discussed above in the previous section is only one contributing factor to the emergence and dissemination of antibiotic resistance. There are many other aspects of antibiotic use