## Supplementary Materials: Scenario Rational and Description

### *A priori* scenarios

#### Scenario 1: Increased infection prevention and control (IPC) under current conditions

The first intervention explored was increased (better) infection prevention and control, both on-farm (e.g. biosecurity) and in health and social-care settings. This scenario was operationalized by increasing the activation value of two components: *non-AM infection prevention and control in food-animal agriculture* and *non-AM infection prevention and control in health and social-care*. In the base FCM, these two components had activation values of 0.5 (medium). To assess how increasing infection prevention and control impacted the indicator components, the activation level of these two components were increased by three different levels to reflect different intensities of the intervention (Supplementary Materials, Table S1).

#### Scenario 2: Educational campaign under current conditions

The second intervention explored was increasing knowledge about AMs and proper AMU through educational campaigns. This was conducted by changing the activation value of two nodes*: consumer demand for AMs* and *appropriate prescribing practices*. These two nodes reflect educational campaigns targeted to the general population (consumers) and to prescribers. It was assumed that educational campaigns have the ability to decrease consumer demand for AMs and increase appropriate prescribing. This was reflected by decreasing activation values for *consumer demand for AMs* component and increasing activation values for *appropriate prescribing,* each by three levels to reflect different intensities of the intervention (Supplementary Materials, Table S1).

#### Scenario 3: Antimicrobial stewardship under current conditions

The third scenario represented increasing antimicrobial stewardship which was a combination of the first two scenarios, increasing infection prevention and control and educational campaigns (Supplementary Materials, Table S1). This scenario was conducted because in complex systems, the effect of combining interventions is not simply the sum of the effect of the two interventions, due to the way the impacts may interact within system (Moore, Evans, Hawkins, Littlecott, et al., 2019).

#### Scenario 4: Increased trade regulations under current conditions

The fourth scenario represented increasing trade regulations. This was based on the European Union’s recommendation, and one countries early decision to ban the importation of all animal-based food products from animals that have received growth promoters (Agence Europe, 2022). The component *domestic and international trade* represents the strength of trade restrictions for food being imported into Sweden and is focused on restrictions around AMU and the presence of AM residues and AROs in imported food. Therefore, increasing the activation value of the *domestic and international trade* node would represent stronger restrictions being implemented and was assessed at two levels higher (stronger) and one level lower (weaker) to assess how this component impacts the indicator components. This was because two levels higher was the highest possible level, therefore, we decided to test one lower to total three intensities. The activation values that were inputted for this scenario are found in Supplementary Materials, Table S1.

#### Scenario 5: Climate change conditions

This scenario represents the system under climate change conditions. Climate change conditions were based on predicted impacts due to a changing climate presented in a scenario planning workshop conducted in Sweden by Lambraki et al. (2022). This workshop explored two interventions under an alternative future (climate change conditions). Experts were presented with a description of the world in 2050 which included a representation of how the changing climate had altered many aspects of the system (Lambraki et al., 2022). These were reflected in the FCM by altering eight components: *disease in plant agriculture, food-producing animal illness, illness in humans, chronic illness in humans, on-farm production of conventional crops, on-farm production of conventional animal-based food products, on-farm production of organic food,* and *movement of people.* Changes in climate are predicted to increase disease in crops, humans, and animals due to extreme weather, heat stress, and the introduction of new pathogens (e.g. vector-borne disease agents). Chronic illnesses such as lung cancer and asthma are also predicted to increase due to poor air quality resulting from pollution and wildfires. The changing weather patterns are also predicted to decrease production of animal-based foods (both terrestrial and aquatic) due to increased stress, decreased immune system function, decreased reproductive health, and destruction of habitat. However, since the temperatures are predicted to increase in Sweden, climate change also allows for longer growing seasons and expanding production areas of crops such as winter wheat, thus increasing overall production of plant-based foods. Finally, extreme weather within Sweden and globally is expected to increase migration and immigration which will increase the movement of people into and around Sweden. These components were all changed by three levels from their initial value to reflect three levels of severity of the climate change scenario: best-, medium-, and worst-case climate change conditions (Supplementary Materials, Table S1).

#### Scenario 6: Increased infection prevention and control (IPC) under climate change conditions

The fifth scenario assessed the first intervention (increased IPC) under climate change conditions (Supplementary Materials, Table S1).

#### Scenario 7: Educational campaign under climate change conditions

The sixth scenario assessed the second intervention (educational campaigns) under climate change conditions (Supplementary Materials, Table S1).

#### Scenario 8: Antimicrobial stewardship under climate change conditions

The seventh scenario assessed was the third intervention (antimicrobial stewardship) under climate change conditions (Supplementary Materials, Table S1).

#### Scenario 9: Increased trade regulations under climate change conditions

The eighth scenario assessed was the fourth intervention (increased trade regulations) under climate change conditions (Supplementary Materials, Table S1).

### *A posteriori* scenarios:

#### Scenario 10: Reducing cost as a barrier for access to nutritious food and sustainable agriculture under current conditions

This intervention aimed to address two of the SDG: The second SDG (Zero hunger), and the twelfth SDG (Responsible consumption and production; United Nations, 2022). It was mentioned within the scenario planning workshops that cost was a major barrier for addressing both of these SDG (Lambraki et al., 2022). Access to nutritious and sustainable food requires money, which makes it unavailable to some populations. In this model, sustainable food could be represented by organic and other non-conventional production systems and animal welfare-friendly food. Therefore, if national budgets were used to provide subsidies to farmers to convert their farms to these more sustainable production systems, and to reduce the extra production costs that are associated with raising animals and growing crops under these systems, we could shift more farmers to adopt alternative and potentially better farming practices. These subsidies could also be used to reduce the end costs to consumers, thus reducing cost as a barrier for consumers to buy foods grown under more sustainable conditions. Therefore, this intervention was modelled by altering eight relationships at three different intensities to reflect the success and strength of the intervention. The subsidies would be targeted at reducing the impact that animal welfare friendly farms and organic production systems has on production costs, reducing the impact of these systems on the retail costs of the food, and reducing the impact that cost has on demand for these products (Supplementary Materials, Table S3).

#### Scenario 11: Increased international trade regulations and implementation under current conditions

Increased trade regulations and implementation addressed the seventeenth SDG (Partnerships for the goals), which aims to strengthen implementation and revitalize global partnerships for sustainable development (United Nations, 2022). This intervention is similar to the previously outline trade intervention (Scenarios 4 and 9) but is more targeted at implementation and enforcement. Therefore, instead of simply increasing the strength of the regulations globally around AMU in agriculture and AROs in food being imported, we wanted to see how increasing the influence that these regulations have on agricultural AMU and AROs in imported food can affect the indicator components. We assumed that if new international guidelines and restrictions (on AMU and AROs from imported food) were implemented such as the new EU trade restrictions (United Nations, 2022), that this would have a stronger impact on changing use practices on farm in the exporting country and that there would be more screening for AROs in foods being imported into the country (Supplementary Materials, Table S3).

#### Scenario 12: Technological advancements and innovation under current conditions

The twelfth intervention, technological advancement and innovation, aimed to address the ninth SDG (Industry, innovation, and infrastructure; United Nations, 2022). It was mentioned within our scenario planning workshops that technological advancements could have the power to change the system, especially when focused on reducing AMU (Lambraki et al., 2022). One major technological advancement that was mentioned was the enhancement of rapid diagnostic technology to be able to detect organisms and inform prescribing decisions (Lambraki et al., 2022). Therefore, we wanted to assess if better diagnostics have a more positive influence on appropriate prescribing and thus could reduce AMU and AMR. Alternatives to AMs is another innovation that could have an impact on AMR. If alternatives to AMs become as good or better at killing organisms, this could have a large impact on reducing AMU in humans and agriculture. Therefore, we wanted to assess if the development of better alternatives to AMs could reduce AMR and alter our other indicator components for the better (Supplementary Materials, Table S3).

#### Scenario 13: Addressing social inequalities and poverty under current conditions

Addressing social inequalities and poverty aimed to address the first SDG (No poverty) and the tenth SDG (Reduced inequalities; United Nations, 2022). During the scenario planning workshops the experts highlighted that addressing social inequalities was a major factor in reducing illness and some of the major drivers of AMU and AMR (Lambraki et al., 2022). Vulnerable populations are at a disadvantage in terms of access to healthcare and nutritious food, and are at higher risk of illness. Addressing the socioeconomic factors that lead to poverty and vulnerable populations is a difficult task. However, if social supports could be enacted to help reduce some of the negative impacts that vulnerable populations endure, this could be a starting point. Therefore, our intervention aimed to reduce the impact that population vulnerability has on access to nutritious food and healthcare (thus increasing access to nutritious food and healthcare to these populations), and reduce the impact that population vulnerability has on negative health outcomes (communicable, non-communicable, and psychological health issues) (Supplementary Materials, Table S3).

#### Scenario 14: Reducing cost as a barrier for access to nutritious food and sustainable agriculture under climate change conditions

The fourteenth scenario was the intervention for reducing cost as a barrier for access to nutritious food and sustainable agriculture under climate change conditions (Supplementary Materials, Table S3).

#### Scenario 15: Increased trade regulations in the European Union under climate change conditions

The fifteenth scenario was the Increased international trade regulations and implementation intervention under current conditions (Supplementary Materials, Table S3).

#### Scenario 16: Technological advancements and innovation under climate change conditions

The sixteenth scenario was the technological advancements and innovation intervention under current conditions under climate change conditions (Supplementary Materials, Table S3).

#### Scenario 17: Addressing social inequalities and poverty under climate change conditions

The seventeenth scenario was the addressing social inequalities and poverty intervention under climate change conditions (Supplementary Materials, Table S3).

#### Scenario 18: The Hail Mary scenario

After analyzing the *a posteriori* scenarios it was evident that the interventions had impacts on many of the indicator variables, but they were not overly impactful at reducing AMR in any of the sectors (human, animal, plants, or the environment). Therefore, we decided to test all of the *a posteriori* interventions simultaneously to see if they could reduce AMR (Supplementary Materials, Table S3).

**REFERENCES:**

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