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A-LA-CARTE
Assessing limits of adaptation to climate change and opportunities for resilience to be enhanced

Adaptation challenges for Finnish agrifood systems and biodiversity under a changing climate – key messages of the A-LA-CARTE project

The A-LA-CARTE project investigated the resilience of agrifood systems and biodiversity under a changing climate in Finland. In particular, it examined observed and future impacts of climate change, the effectiveness and limits of adaptation for reducing adverse impacts, and options for enhancing resilience. The study of agrifood systems, focused on food supply by farms and access to food by consumers (see key messages 1-3). The biodiversity study examined impacts of climate change on bird distributions and the regulatory barriers that may limit the effectiveness of conservation measures as an adaptation response (key message 4). Linkages between agriculture and biodiversity were also examined in a study of grassland butterflies (key message 5). Each of the messages is presented as **challenges to adaptation** under a changing climate, followed by potential **solutions** for addressing these challenges.*

1

Yields of current cereal cultivars are estimated to decline under the warmer and wetter climatic conditions projected for Finland during the 21st century, while grass yields benefit from the lengthening growing season.

For a moderately warm and wet climate scenario typical of projections for Finland by the end of the century, the risk of early summer drought for spring-sown cereals differs little from baseline conditions (1971-2000), while high temperature stress around heading and risk of reduced yield potential during grain filling become more severe, especially in south-eastern Finland. In a broader study with 16 scenarios, the most risk-prone areas for spring cereals are found in south-west Finland, shifting to south-east Finland towards the end of this century [1, 2]. Model simulations demonstrate that the shortened growing period reduces cereal yields with current cultivars, though this effect can be offset to some extent by substituting longer-season cultivars (Fig. 1). In contrast, grass yields will be enhanced as the growing season lengthens and assuming that adequate moisture is available. Altered crop rotation, by exploiting the diversity of crop responses to climate change, can relieve pest and disease pressures and maintain average levels of yield, assuming that the adjustments are economically viable. Farm-level economic modelling suggests that planned adaptation of crop rotations through incentives could offer advantages over autonomous adaptation under changing climate and uncertain market environments [3, 4].

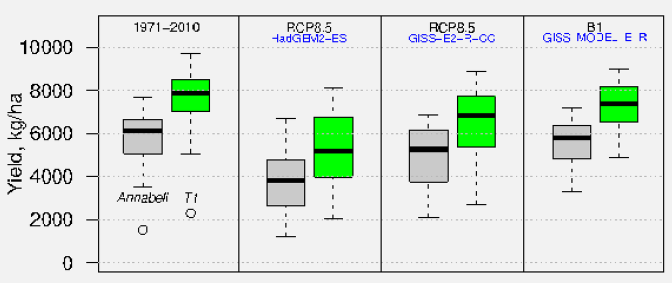

Fig. 1: Simulated water limited yields for a currently barley cultivar (Annabell, gray boxes) and a hypothetical future cultivar that takes advantage of a longer growing season (green) for present-day and three climate scenarios (2041-2060) in Kuopio on fine sand soil.

Maintenance of crop yield levels in Finland under a changing climate will require breeding of new cultivars and active farm management, including appropriate crop rotations. These adaptation measures can be encouraged through policy instruments such as incentives.

2

Due to scarce human and economic resources, small and medium size farms and food enterprises (SMEs) are clearly vulnerable to climate change.

This conclusion is based on a survey and interviews of entrepreneurs from SMEs in three regions: Central Finland, Pirkanmaa and Southern Savo. The case study indicates that localization of food chains can have positive influences on enterprises, local economy and food consumers. Consequently, adaptation to climate change in farms and food enterprises can be characterized as a reactive or autonomous strategy that is often based on *localization* and *decentralization* of the food supply chain as well as on *regional food systems*.

We conclude that values-based strategic partnerships in the food chain could enhance the regions' adaptive capacity and resilience. Further research on regional impacts of climate change on the food supply chain is required to provide decision-makers with a more comprehensive outlook and recommendations.

SMEs are also key actors in building local networks that can increase resilience of local/regional food supply chains.

3

Despite an increased diversity of alternative barley cultivars, the diversity of their responses to weather effects has declined in recent decades, increasing farm-level vulnerability and decreasing resilience to future changes in average climate and variability.

An analysis of the factors that are of importance for the yield responses of different barley cultivars to weather and management in different parts of Finland demonstrated that: despite a continued increase in cultivar diversity of barley (i.e. more cultivars on the market), the diversity in responses to weather among these types declined during the last decade in the regions where most of the barley is grown in Finland (Fig. 2). This was due to greater homogeneity in responses among new cultivars than among older ones (favouring spring drought resistance over other climate risks). Such a decline in the response diversity indicates increased vulnerability and reduced resilience [5]. Possible adaptation measures include continued co-operation with plant breeders as well as discussions with other relevant partners in industry, seed retailers, and the national emergency supply agency. Enhanced response diversity would both increase sustainability of barley production in Finland and provide a practical demonstration of resilience policy.

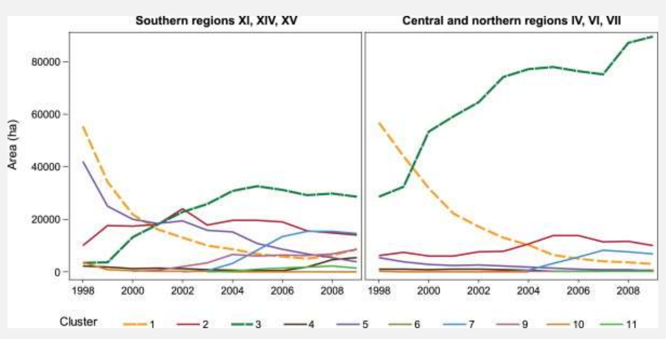

Fig. 2: Cultivation area of the barley cultivar response clusters in Finland for clusters of cultivars with a similar response to weather phenomena.

The concept of response diversity, by spreading risk, can be used as a means of increasing the resilience of barley cultivars in Finland.

4

The efficiency of protected areas preserving biodiversity in a changing climate in the future varies between habitats. Adjustments to the protected area network will be needed; however, the Finnish nature conservation law does not provide an effective framework for facilitating adaptation of biodiversity to climate change.

In forests in the southern and middle boreal zones, only a small proportion of the protected habitat was included in the 5% hotspots, indicating that the efficiency of the protected area network will be insufficient for forest birds in the future. In the northern boreal zone, the efficiency of the reserve network in forests was highly dependent on the strength of climate change varying between the scenarios. In contrast, in species of mires, marshlands and Arctic mountains, a high proportion of protected habitat was included in the 5% hotspots of species in the scenarios in 2051–2080, showing that protected areas cover a high proportion of occurrences of bird species [6].

In order to support biodiversity adaptation to climate change the focus of conservation should be on maintaining ecosystem resilience. However, the contemporary Finnish nature conservation legislation provides adequate legal protection only for special environmental values and places of special importance, and fails to protect biodiversity at the wider landscape in a strategic manner. In addition, the criteria for selecting protected areas and objectives for their management do not take into account species future needs. Finally, the regulatory system lacks mechanisms to support active conservation measures, such as ecosystem restoration. The contemporary nature conservation legislation and its strict interpretation may even discourage conservation on private lands and stand in a way for species translocations [7, 8].

The Finnish nature legislation needs to better protect biodiversity in a wider environment, incorporate mechanisms to encourage active conservation measures and to support adaptive management.

5

Habitat loss depletes grassland butterfly biodiversity and hampers species dispersal.

Dynamic modelling shows that grassland butterflies have difficulties to disperse into new areas [9]. For instance, habitat specialists such as *Maniola jurtina* migrate relatively slowly northwards, by ca. 10 – 20 km in 50 years. Biodiversity-related AES measures might contribute to mitigating the decline of farmland biodiversity but their uptake has been limited [10]. Dispersal corridors could enhance species range shifting. However, their construction costs are high [10]. Assisted colonization is a cheaper option but its success depends on the amount of suitable habitat. The survival probability of specialist butterfly populations created with assisted colonization is often low in modern-day agricultural landscapes (Fig. 3).

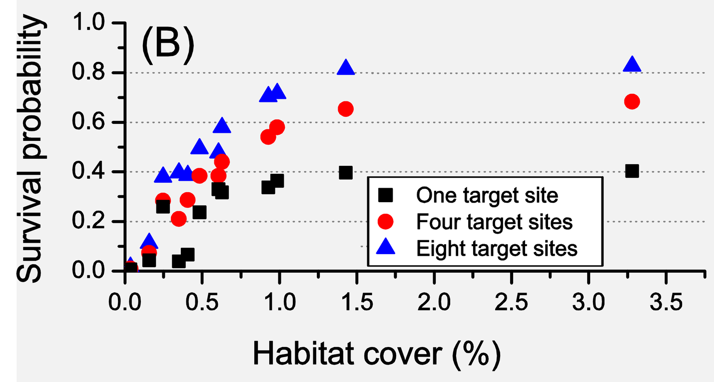

Fig. 3. Survival probability of 40 translocated *Maniola jurtina* individuals released in one, four or eight target sites vs. cover of habitat in the target landscape. Probability measured using RangeShifter, a dynamic species' range expansion model.

Dispersal corridors and assisted colonization may help grassland species to adapt to climate change, but the construction of corridors is expensive and the outcome of assisted colonization uncertain. A third adaptation option is provided by biodiversity-focused Agri-Environmental Scheme measures, but these are seldom applied.

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