# Supporting adaptation of farming systems to climate change and uncertainty

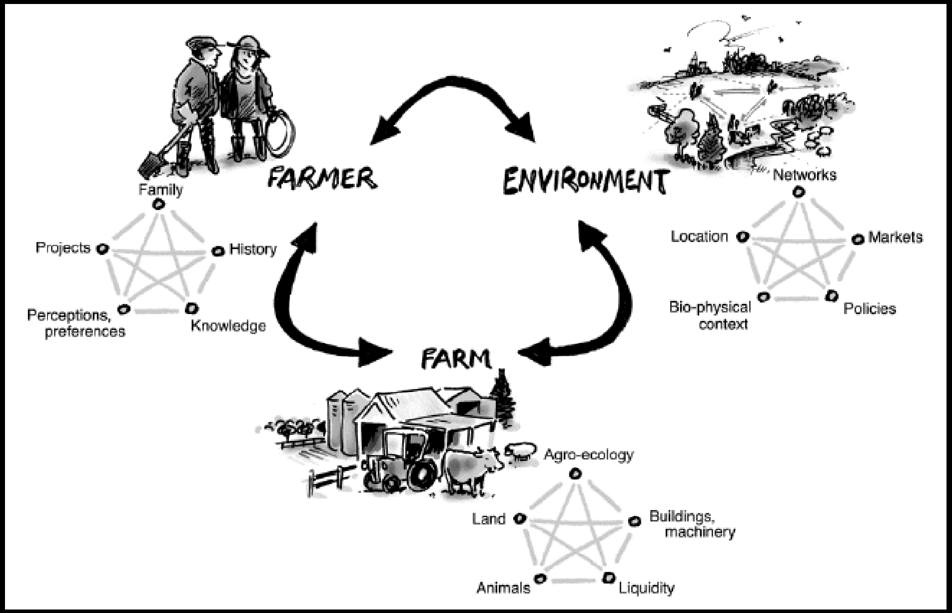
Guillaume MARTIN

INRA, France

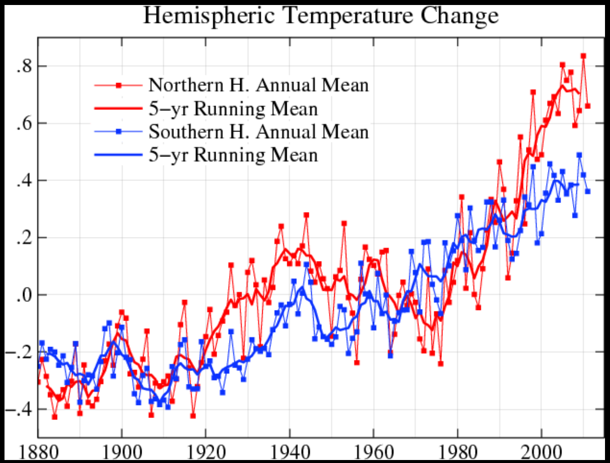
gmartin@toulouse.inra.fr

# Complex systems, Complex challenges

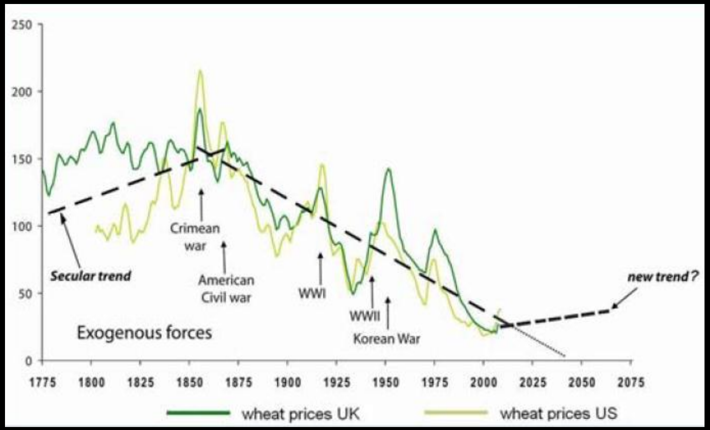
Uncertain, dynamic and interrelated changes in the production context




Darnhofer et al., 2012



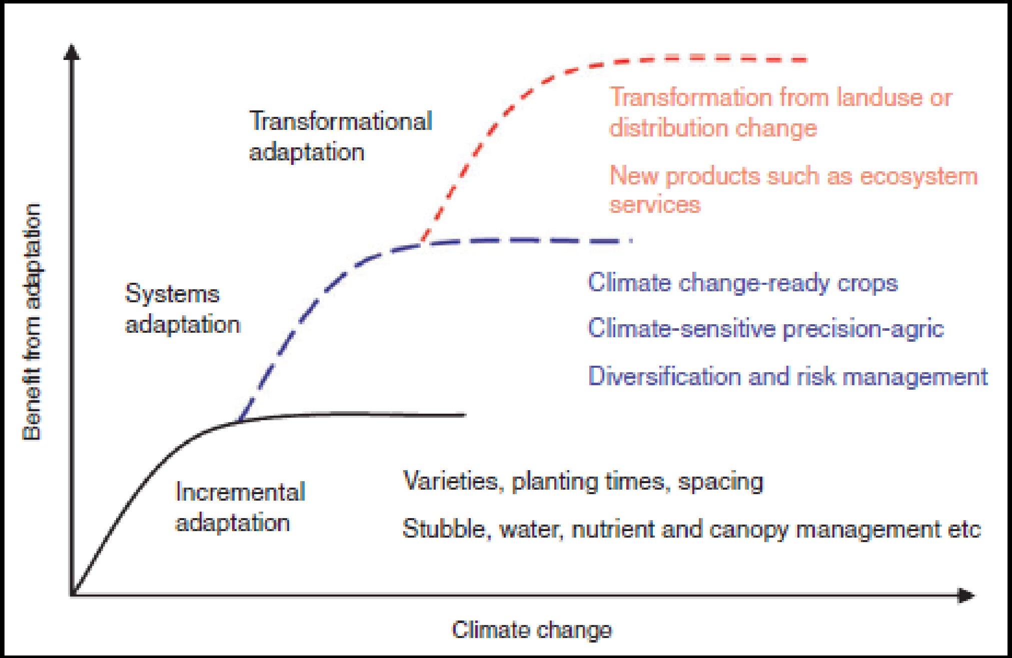

NASA, 2012



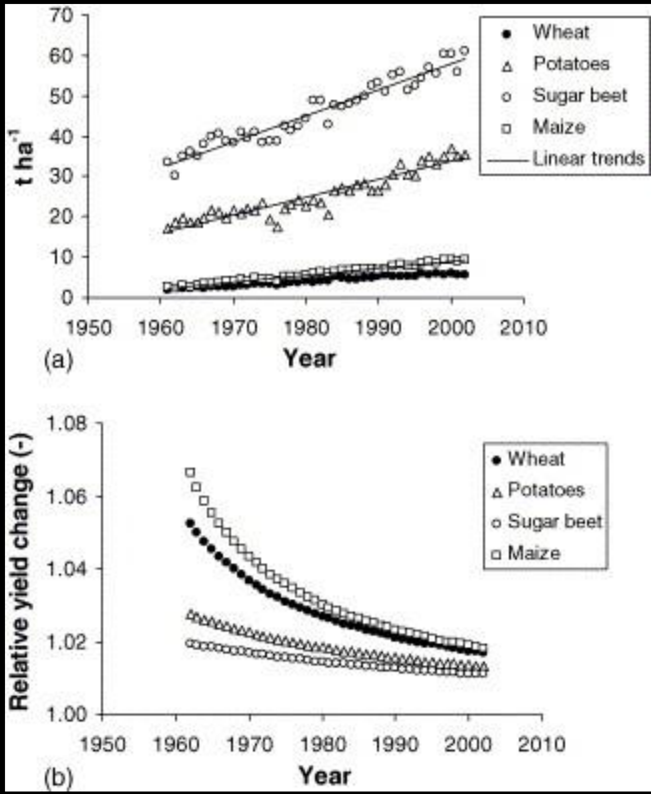

Koning & van Ittersum, 2009

# Adapting LFS to climate change

Continuous adjustment of objectives, practices, processes and capital in response to climate-related events and to the wider - social, institutional, etc. - context (Füssel, 2007; Howden et al., 2007)




Howden et al., 2010




Observed yields and relative yield changes for several crops in Europe
Ewert et al., 2005

# Adaptation of LFS and Learning

- Complexity x Uncertainty

➔ Supporting continuous learning of agricultural stakeholders (Collins & Ison, 2009; Jiggins & Röling, 2000; Pretty, 1995) to develop a repertoire of potential adaptations

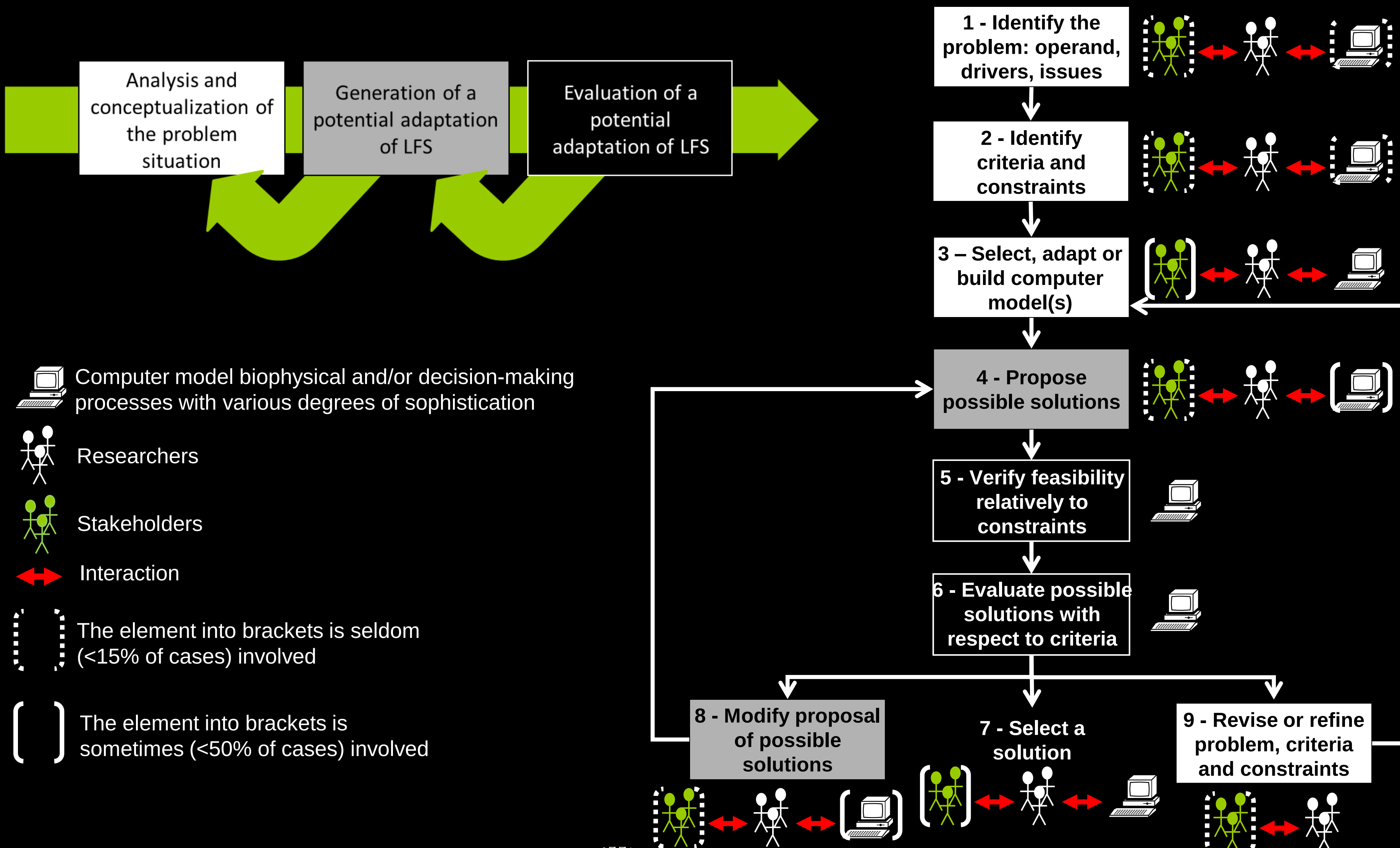
- Improve the adaptive capacity of agricultural stakeholders to cope with change and uncertainty (Duru et al., in press)

- Focus on adaptation and learning
  - At the farm-scale / Local context
  - For individual decisions / Local networks
  - In grassland-based and mixed livestock farming systems

# 2 approaches to supporting adaptation of LFS

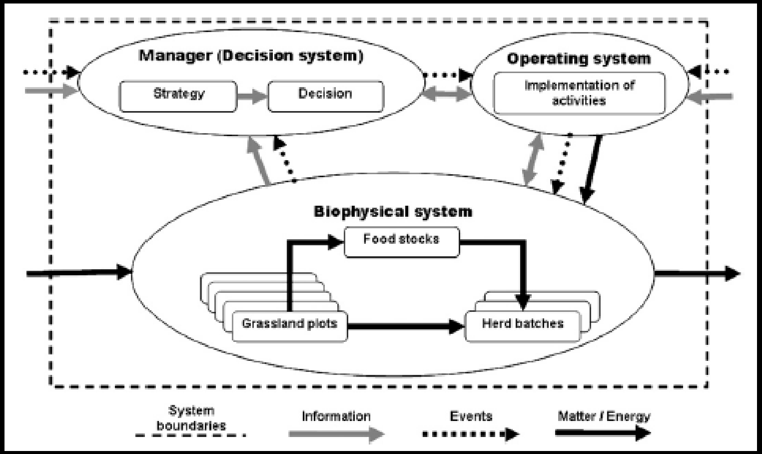
- Hard approaches (e.g. bio-economic modelling)
  - Mainly based on data from physical, chemical, physiological and ecological processes
  - Systems viewed as real entities with given boudaries and goals
- Soft approaches (e.g. participatory rural appraisal)
  - Mainly based on human interaction, learning, conflict resolution, agreements and collective action
  - Systems viewed as social constructs with negociated boundaries and goals
- A key difference regards observability and quantification of causal factors

# Hard approaches




Martin et al., in press

# Example of the SEDIVER simulation model

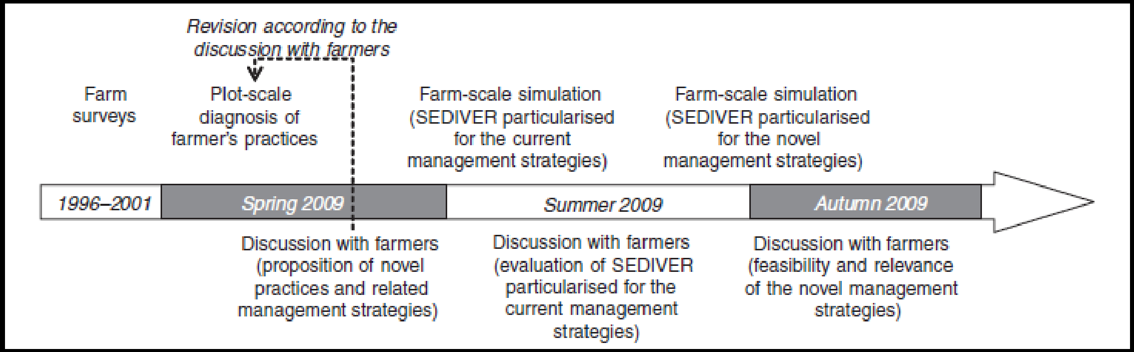



Martin et al., 2011b

Mechanistic LFS model

Emphasis on the modelling of farmer's decision and action

Developed to be support adaptation of LFS to climate variability




Martin et al., 2011c

Evaluation of feasibility and relevance of LFS adaptations confirmed by practice

Parameterization required for locally-relevant simulation outputs is tough

# Pros and cons of hard approaches

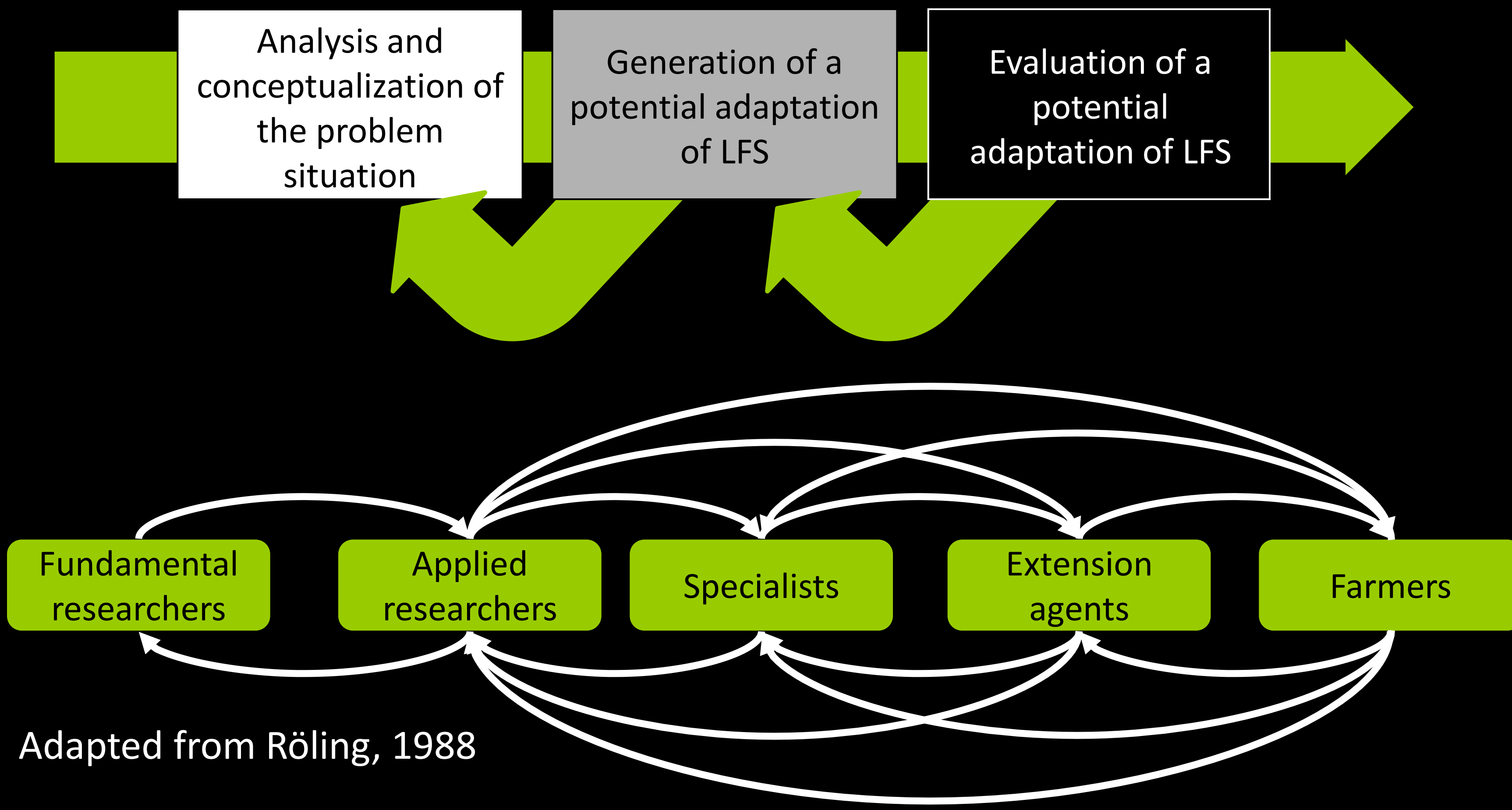
- Integration of complex interactions
- Ex-ante evaluation of potential adaptations of LFS

BUT…

- Mathematical sophistication but contextual naivety (Ackoff, 1999)
- Risk of getting lost in their complexity (Cacho et al., 1995)
- ‘Black boxes’ lacking transparency
- Problems are socially-constructed (Ison et al., 1997)

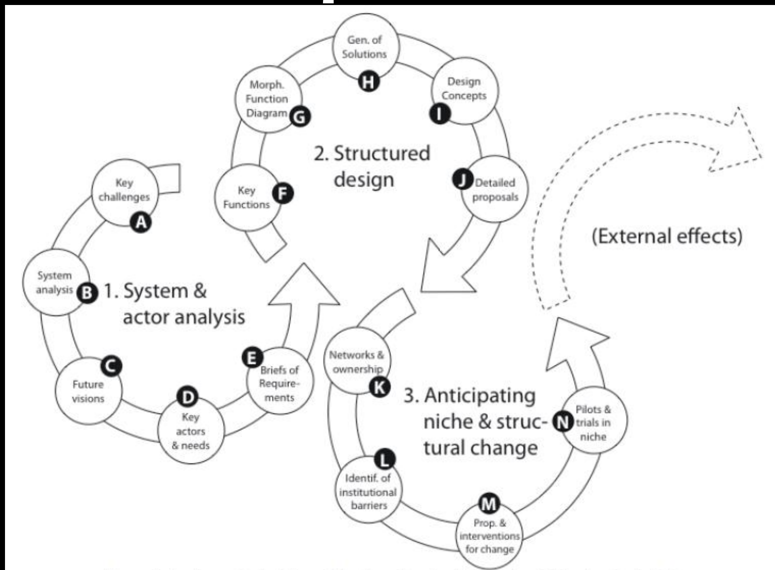
- Feasibility and legitimacy of potential adaptations is questionable
- Problems is less in the models than in their use

# Soft approaches




Adapted from Röling, 1988

# Example of the RIO methodology

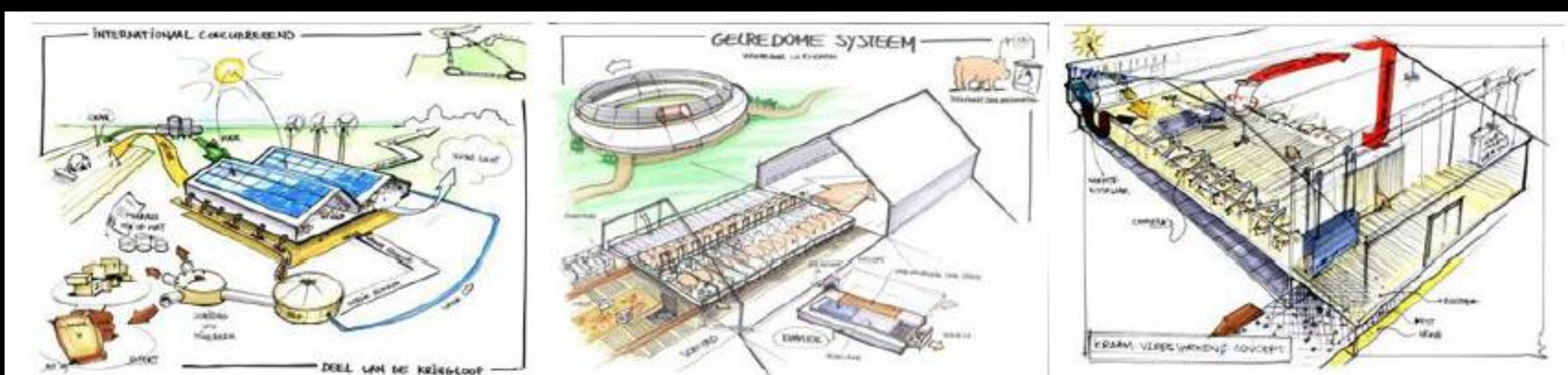



Bos et al., 2009

Participatory technology assessment

Deliberation: assumptions, norms, knowledge claims, distinctions, roles and identities are critically discussed

Porkunities: 3 rounds of design with successive enlargement of the design team




van Eijk et al., 2010

# Pros and cons of soft approaches

- Recognition of the value of local knowledge (Thompson & Scoones, 2009)
- Flexible and transparent → creativity of stakeholders

BUT…

- Human capabilities: skills (observation, optimization) and knowledge
- Human relations: openness to change and to learn, power relations (Leeuwis, 2004)
- Local knowledge: not neutral but embedded in a specific context
- Climate change: unprecedented rate of change, knowledge gaps, methodological challenges (Füssel, 2007)

- Relevance and feasibility of potential adaptations is questionable
- Problems is less in stakeholders' knowledge than in its use

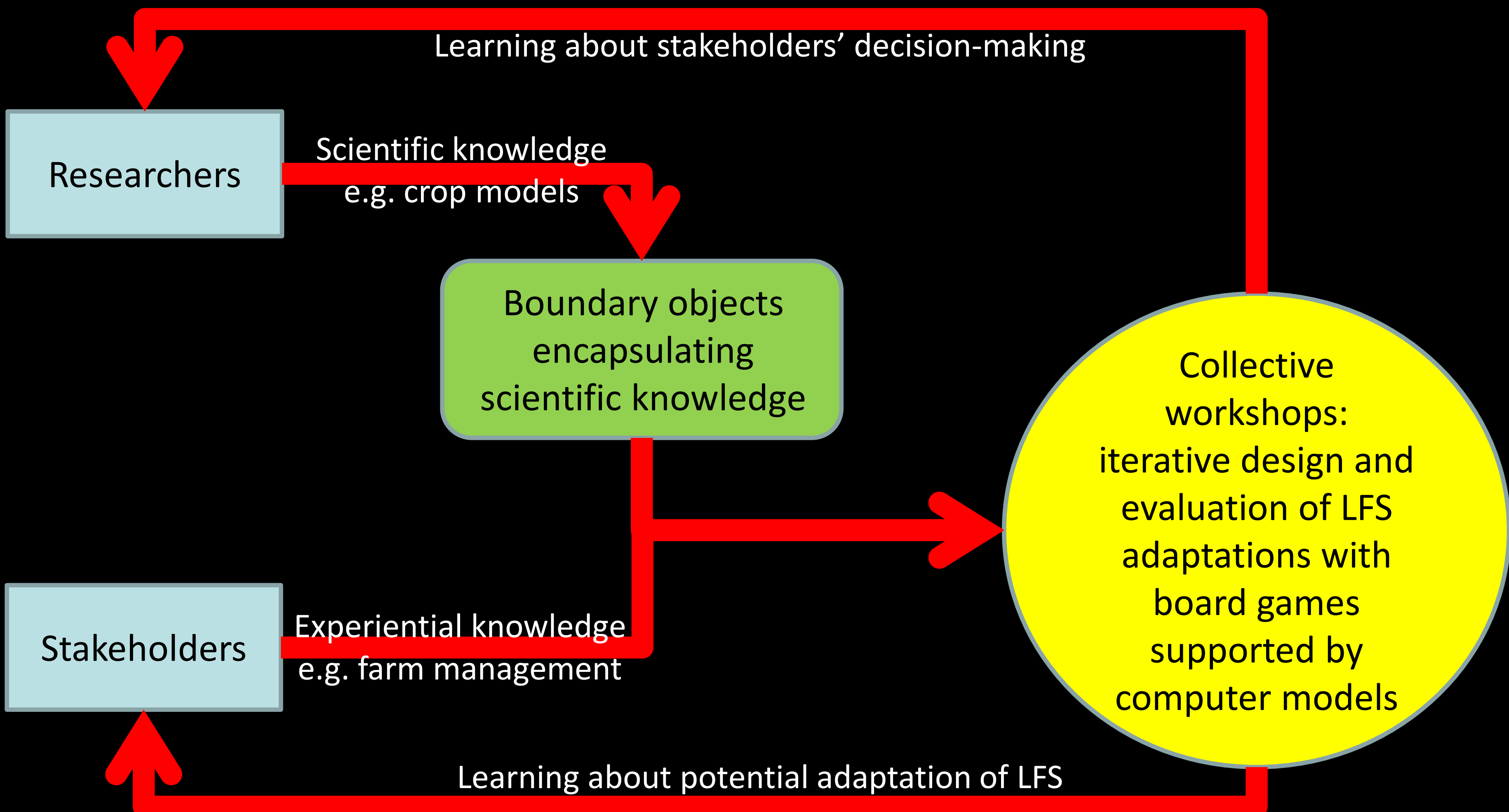
# A need for hybridization!

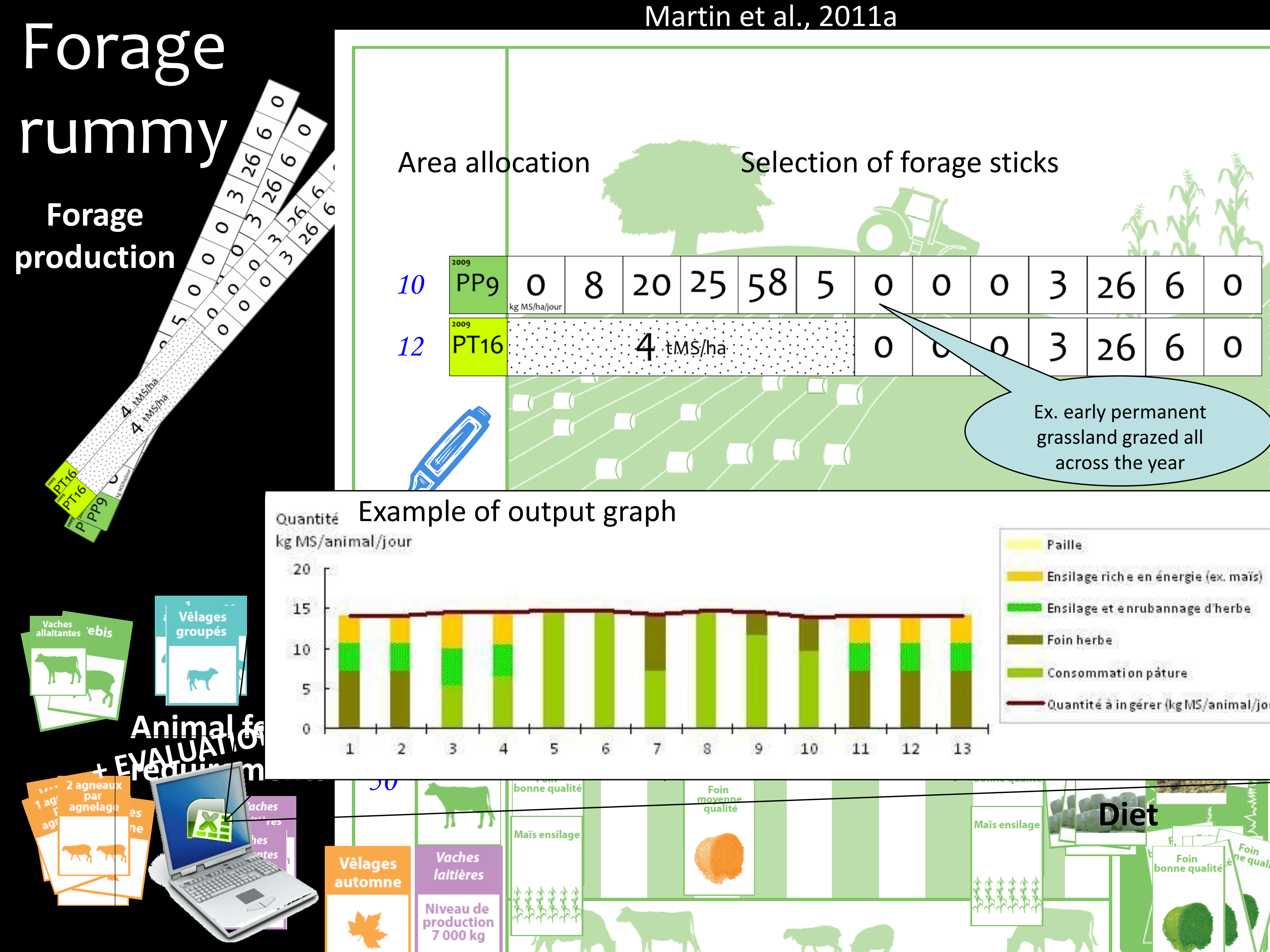
| **Hard approaches** | **Soft approaches** |
| --- | --- |
| Contextual naivety | Local knowledge → contextual relevance |
| ‘Black boxes’ | Transparency |
| Problems are socially-constructed | Interactions between stakeholders |
| Integration of complexity with the models | Limits of human capabilities |
| Integration of up-to-date scientific knowledge | Knowledge gaps e.g. related to CC |

# Key principles

- Open research settings (e.g. involve stakeholders from the very beginning)
- Make research settings fun (e.g. use games)
- Seek for learning as opposed to ready-made solutions (e.g. use simulation to experience a variety of situations in a limited time frame)
- Keep computer models simple (e.g. avoid complex decision-making modelling), interactive (e.g. live assessment) and usable
- Stop using models in a prescriptive / normative way, stimulate human creativity and learning
- Synergize knowledge (e.g. combine up-to-date scientific knowledge and locally optimized agronomic practices)

# Conceptual framework: a game-based approach



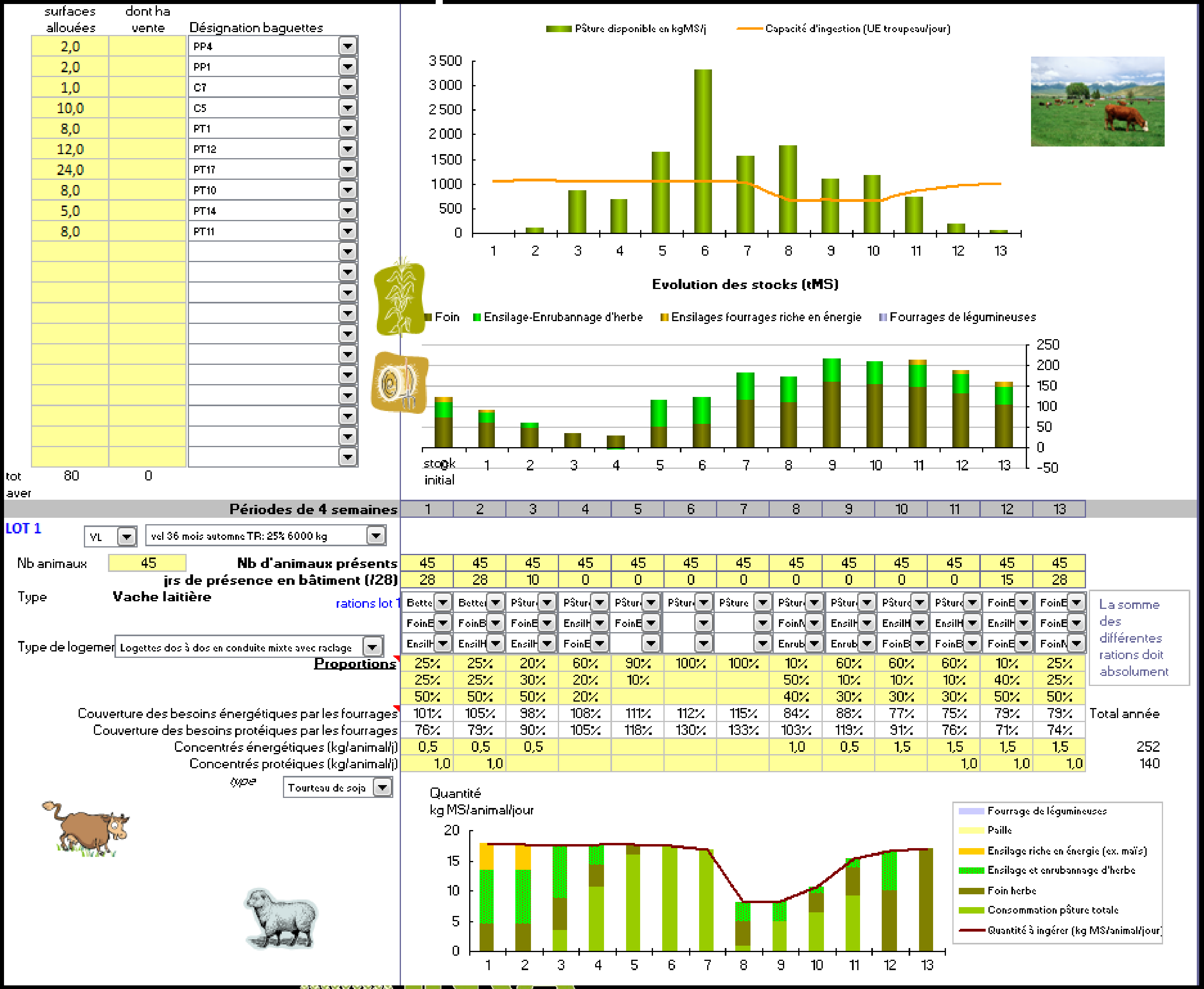


Martin et al., 2011a
Forage rummy
Forage production
Area allocation
Selection of forage sticks
10
2009 PP9
0 8 20 25 58 5 0 0 0 3 26 6 0
kg MS/ha/jour
12
2009 PT16
4 tMS/ha
0 0 0 3 26 6 0
Ex. early permanent grassland grazed all across the year
Example of output graph
Quantité
kg MS/animal/jour
Paille
Ensilage riche en énergie (ex. maïs)
Ensilage et enrubannage d'herbe
Foin herbe
Consommation pâture
Vaches allaitantes
Vêlages groupés
2 agneaux par agnelage
Vêlages automne
Vaches laitières
Niveau de production 7 000 kg
Foin bonne qualité
Maïs ensilage
Foin moyenne qualité
Diet

# Example of LFS adaptation in W. France

LFS developed for an average climatic year

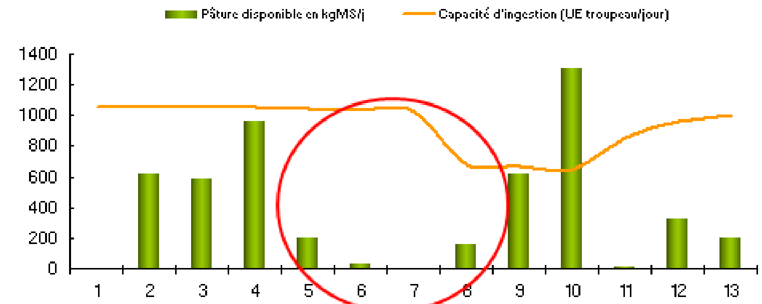
A lot of hay production (e.g. for heifers), no legumes-based forage, little forage beet

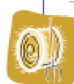


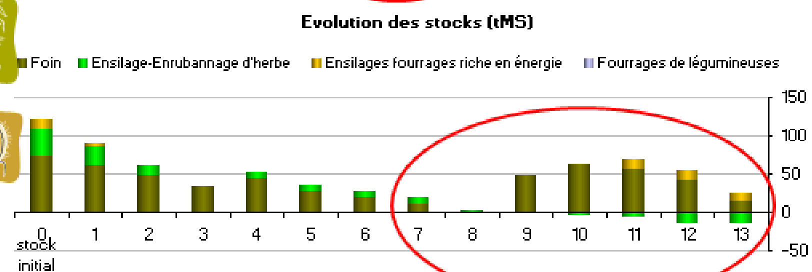
# Spring drought!!

| surfaces allouées | dont ha vente | Désignation baguettes |
|---|---|---|
| 2,0 | | PP4 |
| 2,0 | | PP1 |
| 1,0 | | C7 |
| 10,0 | | C5 |
| 8,0 | | PT1 |
| 12,0 | | PT12 |
| 24,0 | | PT17 |
| 8,0 | | PT10 |
| 5,0 | | PT14 |
| 8,0 | | PT11 |
| tot 80 | 0 | |

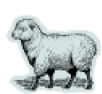
aver

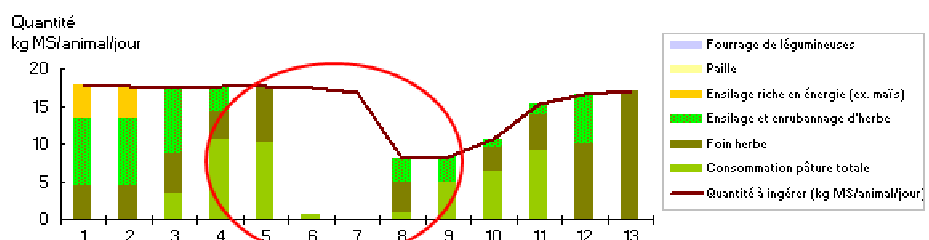





| Périodes de 4 semaines | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOT 1 — VL — vel 36 mois automne TR: 25% 6000 kg | | | | | | | | | | | | | | |
| Nb animaux 45 — Nb d'animaux présents | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | |
| jrs de présence en bâtiment (/28) | 28 | 28 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 28 | |
| Type Vache laitière — rations lot 1 | Bette | Bette | Pâtur | Pâtur | Pâtur | Pâtur | Pâture | Pâtur | Pâtur | Pâtur | Pâtur | FoinB | FoinB | La somme des différentes rations doit absolument |
| | FoinB | FoinB | FoinB | EnsilH | FoinB | | | FoinN | EnsilH | EnsilH | EnsilH | EnsilH | FoinB | |
| Type de logement: Logettes dos à dos en conduite mixte avec raclage | EnsilH | EnsilH | EnsilH | FoinB | | | | Enrub | Enrub | FoinB | FoinB | FoinB | FoinN | |
| **Proportions** | 25% | 25% | 20% | 60% | 90% | 100% | 100% | 10% | 60% | 60% | 60% | 10% | 25% | |
| | 25% | 25% | 30% | 20% | 10% | | | 50% | 10% | 10% | 10% | 40% | 25% | |
| | 50% | 50% | 50% | 20% | | | | 40% | 30% | 30% | 30% | 50% | 50% | |
| Couverture des besoins énergétiques par les fourrages | 101% | 105% | 99% | 107% | 113% | 126% | 0% | 85% | 90% | 77% | 77% | 79% | 79% | Total année |
| Couverture des besoins protéiques par les fourrages | 76% | 79% | 89% | 105% | 111% | 129% | 0% | 101% | 111% | 92% | 77% | 71% | 74% | |
| Concentrés énergétiques (kg/animal/j) | 0,5 | 0,5 | 0,5 | | | | | 1,0 | 0,5 | 1,5 | 1,5 | 1,5 | 1,5 | 252 |
| Concentrés protéiques (kg/animal/j) | 1,0 | 1,0 | | | | | | | | | 1,0 | 1,0 | 1,0 | 140 |
| type: Tourteau de soja | | | | | | | | | | | | | | |



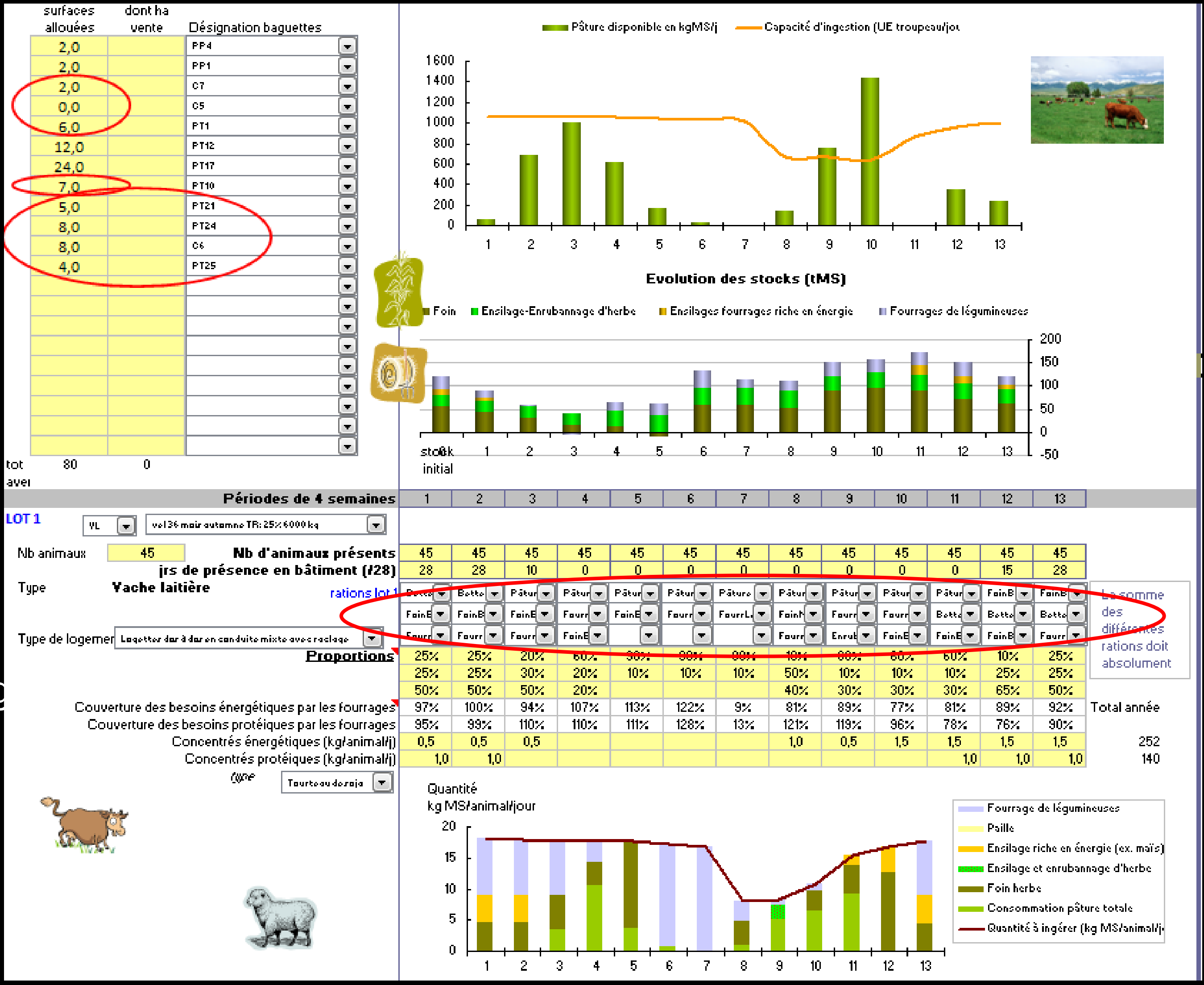


# Based on stakeholders' knowledge and discussions

- Decrease of the dredge area
- Introduction of alfalfa (or alfalfa-dactylis) : good yields even with drought
- Increase of the forage beet area (good resistance to drought)

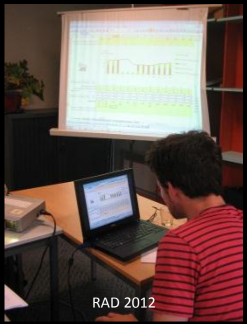
- Change in the diets:
- Heifers: hay ➔ straw Cows: grass silage ➔ alfalfa hay
- Cows: more autumn grazing
- Cows: more forage beet

➔ Higher costs (beet)



# Stakeholders' (86) opinion after 26 workshops

- Something they were waiting for: a reflection support tool to address the systems approach
- Insightful to share knowledge,  compare points of view, identify innovative adaptations…
- Relevant and legitimate information production
- "This winter, we have to lock ourselves away for one day to test and discuss a diversity of LFS designs"

# Conclusion

- Urgency to connect science with action in order to achieve desirable adaptation outcomes (Meinke et al., 2009)

- Game-based approaches are promising
  - Widely used in environmental science (e.g. the ComMod network)
  - Efforts are needed in agricultural science

- Collaborative efforts adaptable to different viewpoints and robust enough to preserve their identity

- Build our capacity in adopting a systems perspective to avoid maladaptations and take advantage of opportunities

# Thanks for your attention

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