

1 **Multi-Dimensional Thinking: A Prerequisite to Agroecology**

2 [Ch. 1 in *Agroecosystems Analysis*, D. Rickerl & C. Francis, eds. American  
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8 Agroecology employs the principles of ecology to study, understand, and design  
9 agricultural systems. One of the most basic principles of ecology is that changing one  
10 component changes everything else. Research and teaching in agricultural science is  
11 evolving from using only the conventional cause and effect or linear mentality to a  
12 holistic approach focusing on sustainability. A holistic orientation requires a more  
13 comprehensive way of looking at things, a more multi-dimensional view. A thought  
14 system such as “Multi-Dimensional Thinking” is not linear, or even circular, but  
15 spherical plus a time dimension. The evolution to this approach is the result of a natural  
16 progression in understanding complexity, and even a logical developmental process. Such  
17 thinking provides a framework or context into which component technologies can be  
18 organized. It is important to define multi-dimensional thinking and provide examples  
19 from different areas of study, or windows on the agricultural system, that we call  
20 disciplines. In conclusion, we discuss multi-dimensional thinking as it relates to  
21 Agroecology.

22  
23 **What is Multidimensional Thinking?**

24 Multi-dimensional thinking is difficult to achieve in our discipline-specific  
25 departments. In some ways we are like the six blind fellows in the poem by John Godfrey  
26 Saxe, “The Blind Men and the Elephant” (Untermeyer, 1963). Each suffers from the  
27 same handicap (each in a specific discipline), and each approaches a different part of the  
28 elephant (specialization). The poem points out that reductionist thinking, even by wise  
29 people, does not often give us the complete picture. Each of the wise people was partly in  
30 the right, but all in the wrong, in terms of the larger structure and function. These  
31 specialists demonstrate that the description of the parts cannot possibly give the whole  
32 picture, and that linear thinking is sometimes inadequate. The large creature we are trying  
33 to understand is agriculture, and the innovative, multi-dimensional approach described in  
34 this book is Agroecology.

35 Multi-dimensional thinking may be considered a prerequisite to the development  
36 of agroecology. A narrow focus helps us become more specialized and productive in our  
37 disciplines, yet may have narrowed our field of vision until we become like the blind men  
38 in the poem with respect to wider issues in agriculture. Since we often relate dimension to  
39 the visual arts, construction projects or geometry, it is useful to begin with several visual,  
40 concrete examples. First, some regional artists from the Midwest.

41 Czestochowski (1981) described Grant Wood as an artist who “gave expression  
42 to a living experience” and whose “art narrates the frenzied transformation in American  
43 values from those of a rural community to those of an urban-industrial  
44 society...reaffirming the uniqueness of American culture as a social and environmental  
45 phenomenon”. Wood mastered the illusion of dimension. It is easy to see the differences  
46 in dimension among Grant Wood’s paintings. “Plowing on Sunday,” with only the farmer

1 in the foreground, is uni-dimensional (Fig. 1); “American Gothic” is a 2-dimensional  
2 presentation of the farmer and his wife in the foreground and a farm house with a Gothic  
3 window in the background (Fig. 2); and “Stone City” (Fig. 3) is a 3-dimensional view  
4 that carries the eye for miles across the Iowa  
5 countryside. These differences in dimension  
6 are perceptions created by the artist.

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11 Visual artists can take another step  
12 and create relief or sculptures that exist in  
13 space as multi-dimensional works. Christian  
14 Petersen’s sculpture “The Cornhusker” (Fig.  
15 4) depicts a young man from Nevada, Iowa  
16 who has won the county, district, and state  
17 husking championships. Bliss (1986)  
18 describes the sculpture as “Petersen’s tribute  
19 to a uniquely Midwestern type of athlete in  
20 the premechanized farm era.” South Dakota  
21 has one of the nation’s most famous relief  
22 sculptures, Mount Rushmore. The viewer is  
23 consumed by the immense life-like faces of  
24 four presidents. An even more immense  
25 mountain sculpture of Crazy Horse is moving toward completion a few miles to the  
26 south. The use of real dimension, and in these examples, scale, adds to the impact, and  
27 their historical relevance adds a fourth dimension of time.

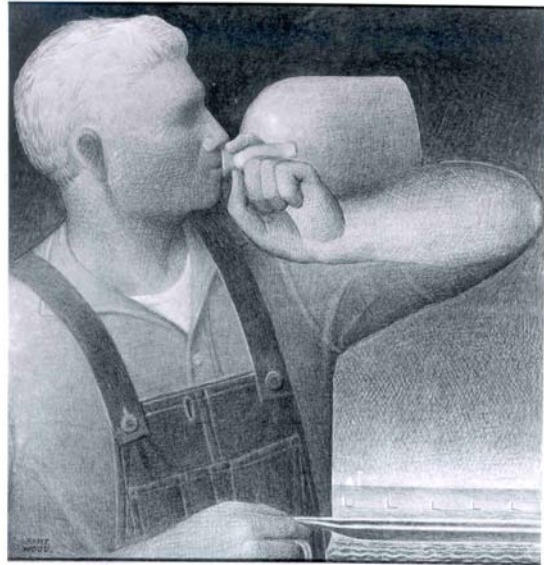


Figure 1

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41 In the 1960s, sculptors started to create environments as their 3-dimensional  
42 work. The impact of works such as “The Farm Worker” (Fig. 5) by George Segal, which  
43 include life size sculptures in a created space, comes from the total environment created  
44 by the artist. Segal (Seitz, 1972) commented about one of his works, “I was responding to  
45 all the polarities, and had to find a way to connect real space, direct sensation, with a  
46 metaphysical dream state. Specific and general  
47 had to become entangled; figure and  
48 abstraction had to fuse.”

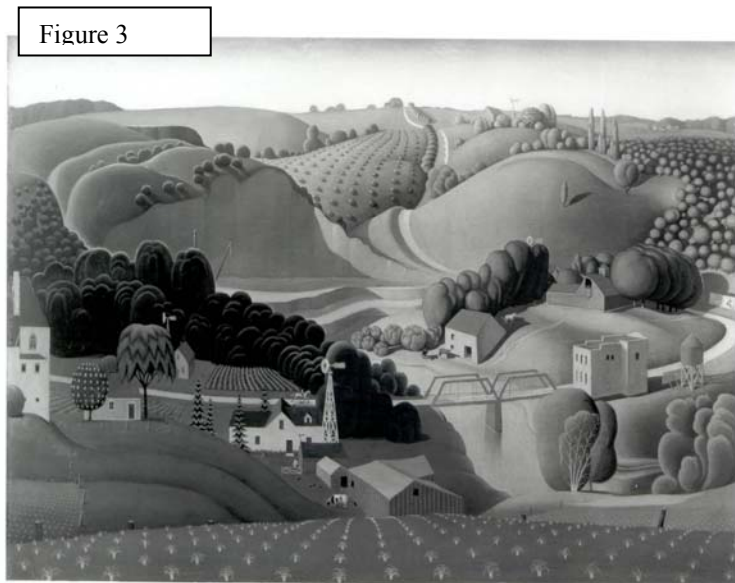
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53 In the study of geometry, dimension is  
54 defined and drawn. Students first learn the  
55 definition of a point, then a line, a plane and a  
56 solid. The concept of volume is not taught  
57 before the concept of area, as that would not be  
58 a logical progression. For most of us, multi-  
59 dimensional thinking has progressed through  
60 our personal development and education, just  
61 as we learned the details of geometry. In  
62 contrast, most courses packaged within  
63 disciplines require us to pull back into thinking  
64 about components of systems, thus address  
65 challenges in fewer dimensions. It is difficult  
66 to assemble the pieces of a puzzle if each has  
67 been modified or fine-tuned without doing this within the context of the larger picture.



Figure 2

1 In Piaget's studies (1973) of intellectual development of children he states, "I will  
2 call it psychological, the development of the intelligence itself – what the child learns by  
3 himself (sic), what none can teach him and he must discover alone; and it is essentially  
4 this development which takes time." Piaget describes sequential stages of development  
5 that proceed from concepts of substance as an empty form to conservation of weight and  
6 finally to conservation of volume. This developmental progression is analogous to the  
7 concepts of point, line, plane, and volume in the principles of geometry. However,  
8 agricultural systems are far more complex, and involve the interaction of many biological  
9 and physical factors, plus human ambitions and survival within the natural and the built  
10 environments. Kirshenmann tells us in chapter eleven (Ecological Morality) that  
11 philosophers, sages and shamans have understood that humans are part of a complex web  
12 of life. Our only chance for understanding how systems function, and how our  
13 component data fit in, is to embrace this complexity, and for some of us to look carefully  
14 at whole systems.

16 Conceptual  
18 development is often  
20 expressed visually in the  
22 progression of a child's  
24 drawings, going from dots  
26 and slashes, to enclosed  
28 shapes, to recognizable  
30 forms (Fig. 6). All of us  
32 have seen the lack of  
34 perspective (dimension) in  
36 children's drawings where  
38 trees and houses sit on the  
40 horizon line. Even projects  
42 built from modeling clay  
44 (a 3-D media) often take  
46 on a 2-dimensional quality



47 in the hands of a young child. Piaget (1973) summarizes,

48 *"This order of succession shows that, if a new instrument of logic is to be*  
49 *constructed, there must always be previous logical instruments, that is the*  
50 *construction of a new notion will always suppose substrata, previous*  
51 *substructures, and this by indefinite regressions."*

52 The medium, modeling clay, cannot be used in 3-dimensional expressions until the  
53 concept of volume has been developed. To suggest that research on component  
54 technology is more "childlike" would be highly erroneous – in fact it may be the systems  
55 integrators who need to revisit this concept of how appreciation of spatial dimension  
56 develops. Perhaps those unencumbered by heavy, component-oriented detail are better  
57 able to grasp the larger issues?

58 Our understanding of geography is an excellent example of the progression of  
59 multi-dimensional thinking. By the time of Christopher Columbus, there had been a great  
60 deal of change in perceptions about the earth. The local "point" focus of prehistoric  
61 humans in their tribal territories progressed to a broader 2-dimensional theory of a flat  
62 earth. With some evidence and multi-dimensional hopes, Columbus began his voyage

1 across the ocean. Even though he didn't know where he was going, or where he had been  
2 when he returned, Columbus' dimensional perception had been enhanced and ideas began  
3 to change. In 1969, when Neil Armstrong walked on the moon as the world watched,  
4 multi-dimensional thinking took a giant step through both space and time.

5 Leonardo da Vinci was an Italian artist and scientist, one of the first "renaissance  
6 men" and an excellent example of a person with multi-dimensional thinking. Best known  
7 for his classical paintings, Leonardo was architect, engineer, anatomist, and sculptor.  
9 Today's university would have difficulty finding a  
11 department or even a college where his immense  
13 talents would fit into the confines of one  
15 discipline.

17 In biological science, an example of multi-  
19 dimensional thinking can be visually illustrated  
21 through advances in the development of the  
23 microscope. Robert Hooke writes in *Micrographia*  
25 (Espinasse, 1956) "...these pores, or cells, were  
27 the first microscopical pores I ever saw, and  
29 perhaps that were ever seen..." His discovery was  
31 named the "cell" because only the lines of the cell  
33 wall were visible using his microscope (Fig. 7).  
35 Hooke was a multi-dimensional thinker. He was  
37 accomplished in science, art, and engineering.  
39 Hooke's friend Wren (Espinasse, 1956) writes, "of  
41 him I must affirm, that, since the time of  
43 Archimedes, there scarce ever met in one man, in  
44 so great a perfection, such a Mechanical Hand and so Philosophical a Mind".



Figure 4

45 With further development, the microscope revealed cell contents as well as cell  
46 walls (Fig. 8). The scanning electron microscope added the third and fourth dimensions  
47 to microscopy (Fig. 9). Today we can watch cells function and follow their life cycles  
48 over time using technology that has progressed from uni-dimensional to three and then  
49 four-dimensional. As in the case of Piaget's intellectual development, each phase in the  
50 development of the microscope built on the previous technology and understanding, and  
51 would have been impossible without it.

52 Computer technology is perhaps today's most rapidly changing example.  
53 Computers initially processed numerical data. Before long they could use instructions to  
54 plot or chart data, then create surfaces and moving 3-dimensional images. Virtual realities  
55 generated by computers today can take us through experiences that are multi-  
56 dimensional. In this case a sense of reality is gained from the combination of visual,  
57 audio and tactile experience. Perhaps we should be grateful that development of  
58 computer imagery has been spurred by the military and by action video games, and that  
59 these advances may soon be applied for more beneficial uses in society. Technology has  
60 allowed the enhancement of sensory perception. It is the illusion of an environment, the  
61 same concept used by Segal.

62 These examples of the progression of multi-dimensional thinking indicate  
63 changes in perception through time. Our perception of time itself has also evolved. In the  
64 ancient Mayan culture it was believed that humans were placed on earth to bear the

1 burden of time, to be the timekeepers. Einstein in his special theory of relativity regards  
2 the time-variable as a Euclidean 4-dimensional continuum. In the words of Niels Bohr  
3 (Clark, 1971), “Mankind will always be indebted to Einstein for the removal of the  
4 obstacles to our outlook which were involved in the primitive notions of absolute space  
5 and time.” The Mayans, Columbus, Neil Armstrong, Hooke and Einstein are just a few  
7 examples of Dimensional Thinkers. Why are  
9 they the exceptions?

11 There are many obstacles to multi-  
13 dimensional thinking. We have discussed  
15 limitations in technology, society, university  
17 department organization, and self. Microscopes  
19 and computers have changed our perceptions and  
21 given us new insights. Societies and their  
23 religions have been obstacles to creative and  
25 multi-dimensional thinking. Popular belief in the  
27 1400s said that the world was flat. Columbus’  
29 theories were rejected in Portugal and initially in  
31 Spain. Only his persistence led to his success.

33 When Einstein proposed that the energy  
35 contained in a light beam is transferred in  
37 quanta, he contradicted a century-old theory.  
39 Almost no one accepted the new proposal. Even  
41 when Robert Andrews Miliken experimentally

42 confirmed the theory a decade later, he was surprised and uncomfortable with the  
43 outcome. Darwin was extremely cautious in explaining his theories on evolution to the  
44 public, often sitting on his results for five years or more. He would also have found  
45 difficulty making tenure in universities today. The views of society, including the  
46 university community, can be a strong limitation, but society can progress just as the  
47 individual progresses through developmental stages.

48 Thomas Kuhn (1996) takes the argument further, suggesting that evidence  
49 contrary to our predominant paradigms can be virtually invisible to the observer. This is  
50 why change occurs on the fringes, and rarely in the mainstream (Barker, 1985). Rachel  
51 Carson's (1962) *Silent Spring* attacked the widespread use of pesticides and precipitated a  
52 radical change in agriculture, but this was only possible because of her biology  
53 background and ability to see the larger picture.

54 Agroecology requires multi-dimensional thinking, or the ability to see the whole  
55 elephant as well as the context in which it functions. The examples given illustrate the  
56 importance of an individual’s psychological development in his/her ability to think in  
57 multiple dimensions. The importance of society and the prevailing views are also  
58 instrumental in shaping science and our understanding of systems. Technology can offer  
59 tools to speed the development of dimensional thinking, but in itself it is not necessarily  
60 multi-dimensional. It takes a unique individual or society to defy the current theories of  
61 culture and/or science to pursue different views.



Figure 5

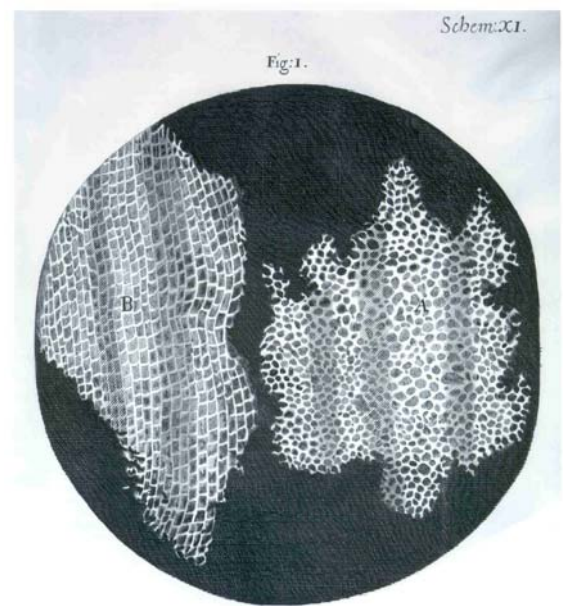


Figure 7

## Pursuing a Multidimensional View of Agroecology

Agroecology has been variously defined as the marriage of agriculture and ecology, the understanding of crop ecology in the context of cultivated systems, and the description of agriculture in ecological terms. Gliessman (1998) traces the history of uses of this term back to the early part of the 20<sup>th</sup> Century, when field ecology and practical agronomy shared common interests in cultivated and natural systems. Crop ecology was an important area of study until ecologists moved toward greater focus on natural systems, and agronomists became more specialized in disciplines related to specific components of the system. The Gliessman chronology has been expanded to include more references from Latin America and Europe in a recent article on defining agroecology as the ecology of food systems (Francis et al., 2003).

What are the dimensions contained in an agroecological view and what approaches can be taken to reach the broad and needed level of understanding? Okigbo (1989) lists five elements that should always be considered for a sustainable food system in a given area, to which we add a sixth dimension related to the environment.

- **physiochemical factors**, soils, climate, moisture, radiation, day length
- **biological elements**, crops animals, pests
- **changing and appropriate technologies** available to the farmer
- **sociocultural background**, education, policy, experience
- **economic viability**, market, costs, management
- **ecological soundness**, preservation of biodiversity and ecosystem functions.

Okigbo emphasizes that these dimensions should each be considered for sustainable development at the global, regional, national and local level. Further discussion of the importance of hierarchy and scale is found in Chapter 2.

Harwood's (1990) history of sustainable agriculture suggests two reference points for the evolution of this concept. The first is "agriculture based on principles of ecological interaction" which emerged in the early 1980's and the second is "stable agriculture in the global sense, involving all facets of agriculture and its interaction with society" which emerged later in the decade. Harwood's own definition, given certain limitations, is "an agriculture that can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favorable both to humans and to most other species." The definition incorporates values, but allows for agricultural development. Harwood reviews a thought development process (multi-dimensional thinking), of major significance to the concept of sustainability. From this process, stemming from the early 1900's, there is

- the interrelatedness of all parts of a farming system, including the farmer and his family
- the importance of the many biological balances in the system

- the need to maximize desired biological relationships in the system and to minimize use of material and practices that disrupt those relationships.

In the late 1900's, as communication and transportation technology enabled global exchange, we began to realize the role of human diversity and community in food systems. Butler and DePhelps (1995) discuss the development of rural and urban communities in America. Their sequence fits the progression from point to sphere to time in multi-dimensional thinking. The "point" is characterized by many small rural communities located in a specific geographic place. Technology allowed interactions between communities with shared interests (linear) as rural communities began to decline. In the 1990's bioregionalism (circular) emphasized the interconnectedness within a geographic region and the idea that cultural identity is connected to the natural environment.

*In a sense, bioregionalism is a shift of emphasis from national or global to local communities within a specific geographic region. This shift does not ignore the relationships between local and global spheres. Rather, it focuses energy within local communities while strengthening relationships between communities, within regions and beyond.*

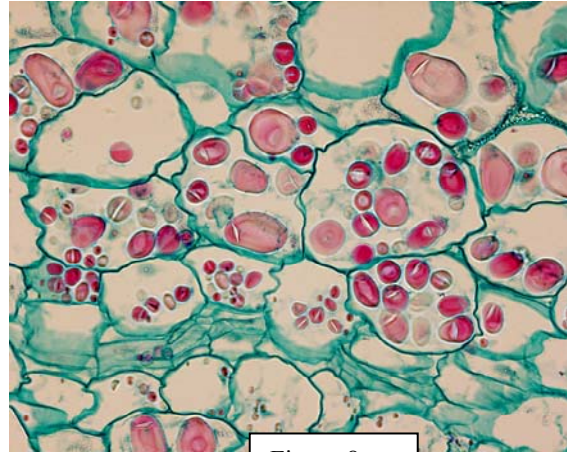


Figure 8

In this view, bioregionalism can become fully dimensional, looking at relationships among interacting spheres. The bioregion becomes a common ground for effective community-based problem solving (multi-dimensional thinking). Further, the relationships among these communities develop and evolve over time, changing in response to demographics, resources, and political circumstances among other factors.

To encourage community member participation a well-developed sense of place is needed. "To know the spirit of a place is to realize that you are part of a part and that the whole is made of parts, each of which is whole. You start with the part you are whole in". Butler and DePhelps (1995) offer approaches for developing what is essentially an agroecological view for community-based problem solving. They suggest techniques and provide examples of strategies that encourage open dialog and create trust among community members.

A recent commentary article proposes the broader definition of agroecology as the "ecology of food systems" (Francis et al., 2003). In this article we suggest that agroecology is an appealing term that helps scientists, farmers, and others focus on both the structure and function of agroecosystems, including the long-term positive and negative impacts of systems on humans and other species. Although focus in agricultural science and current agroecology courses has been primarily on the production components and environmental impacts, Francis and colleagues argue that attention to processing, marketing, and consumption dimensions will help in understanding the total energy and materials flows in the system and lead to design of more efficient resource use and human utility in the systems. One goal of their article is to stimulate teachers and researchers in agroecology to embrace this broader concept of studying the total food

1 system, and thus to add multiple dimensions to our understanding of how systems  
2 function and how they can be improved.

### 4 **Potentials for Agroecology in Universities**

5 The results of a survey of land grant universities conducted by Francis et al.  
6 (1995) suggest that, “There is great potential for cooperative ventures among universities  
7 to address both the sustainability of agriculture and the concerns of society.” Although  
8 most of the current business as usual takes place within the confines of discipline-specific  
9 departments, there are multi-discipline centers and areas of concentration in teaching that  
10 demonstrate how new approaches can be implemented within the current system. A list of  
11 potential future directions focuses on forming/strengthening coalitions and improving  
12 communication networks that bridge the traditional boundaries and create new  
13 communities of scholars who can deal with complex issues.

15 Student demand for education in agricultural systems in  
17 the U.S. and in ecological agriculture in the Nordic Region has  
19 stimulated the search for new approaches to organizing  
21 learning. Lieblein et al. (2000) present a critique of the current  
23 university structure that places all activities in boxes that  
25 correspond to courses in specific topics, too often taught in  
27 isolation from other courses and from the operating world of  
29 agriculture. They point out that today's society is beginning to  
31 demand that ecological, ethical, and social dimensions must be  
33 included in our design of food systems and in shaping the future  
35 of agriculture. If the agricultural universities are unable to  
36 respond to the need for students to understand complexity and the multiple dimensions of  
37 tomorrow's food systems, it is likely that other players will enter the educational arena  
38 (Kunkle et al., 1996).



Figure 9

39 Lieblein et al. (2000) suggest that universities' curricula are based on the  
40 assumption that there is a large gap between ignorance and knowledge, while in reality  
41 there is a much larger gap today between knowing and doing. For this reason, they  
42 recommend active learning based on student projects and greater emphasis on activities  
43 outside the classroom. Their concept of a "future learning university" is shown in Fig. 10.  
44 An expanded definition of faculty to include people from business, government, and  
45 farming can enhance the classroom education, recognizing that students learn in many  
46 ways and in different settings. (Francis et al., 2003). These concepts are being introduced  
47 in the Nordic graduate programs in agroecology and ecological agriculture, the term use  
48 in that region to describe organic farming.

### 50 **Multiple Dimensions of Agroecology**

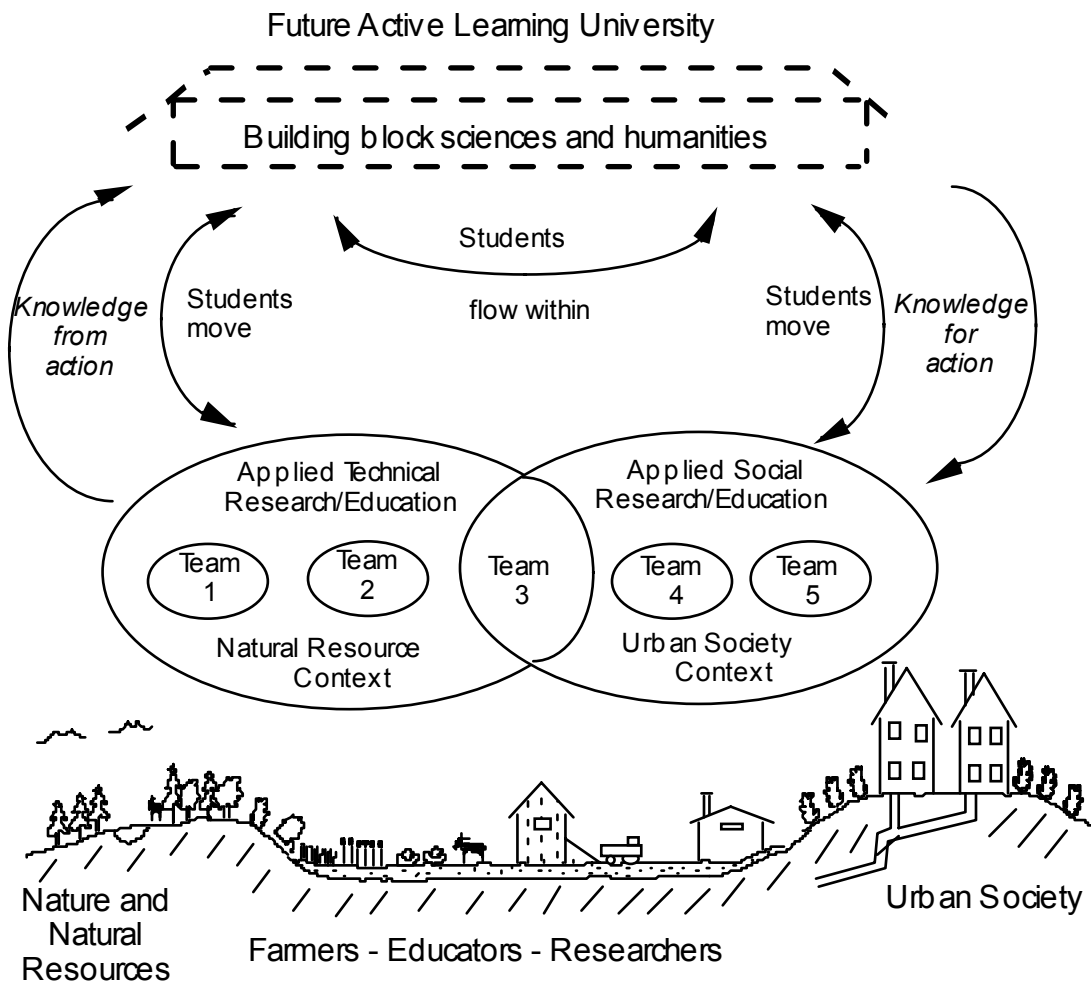
51 This book explores the many dimensions of agricultural systems that are needed  
52 to fully understand how they are structured and how they work. It is convenient to  
53 approach the system at different spatial levels, in order to understand the dynamics of  
54 biological and geochemical reactions that occur there. It is essential to focus on the  
55 foundation of soil and climate to understand how these set limits on potential productivity  
56 of systems. Yet equally important are the human participants in the system and how they



1 design and manage resources to extract food and other products from the agroecosystem.  
 2 It is the multi-dimensional view of these different levels that make this book unique.  
 3

4 Fig. 10. Schematic description of future university for active learning and research, with student and  
 5 faculty learning activities often in the farming environment, and close relationships with both natural  
 6 resource and urban society contexts (from Lieblein, Francis, and King, 2000; reprinted with permission of  
 7 *Journal of Agricultural Education & Extension*, Wageningen, Netherlands).

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The types of structure and the processes that occur at different levels in the spatial hierarchy are described in Chapter 2. The functions of an agroecosystem cannot be well understood unless this is viewed from different points of view, and this requires a multi-disciplinary approach and analysis of system functions. Soil dynamics and plant nutrition

1 are at the foundation of system potential, and our understanding of these processes is  
2 growing as we study the biological complexities of soil organisms and nutrient  
3 interactions unconfounded by massive applications of fertilizers and pesticides (Chapter  
4 3). Insects, weeds, and pathogens interact with crops and animals at the field and farm  
5 levels to influence success of the agricultural enterprises, and the complexity of these  
6 processes is discussed in Chapter 4. The aggregation of functions of individual crop  
7 plants and domestic animals leads to study of the whole farm, and how its dynamic nature  
8 can be directed through alternative approaches to management (Chapter 5).

9 Economics can be used to evaluate agricultural systems in multiple ways. The  
10 neoclassical approach to economic analysis is but one method of evaluating success, and  
11 a multi-faceted approach to measurement is presented in Chapter 6. The importance of  
12 social capital and the dynamics of rural communities are discussed in their many  
13 dimensions in Chapter 7. How the development of systems contributes or detracts from  
14 the conservation of resources is presented in Chapter 8. Global information systems are  
15 extremely valuable in assessing the spatial variability of many dimensions of agricultural  
16 systems, and over time can provide a dynamic picture of how these change (Chapter 9).

17 An emerging interest in agriculture is the multifunctionality of rural landscapes,  
18 and how society recognizes and rewards the ecological services these landscapes provide.  
19 Methods of measuring ecological functions are presented in Chapter 10. Including  
20 humans and their activities as key drivers in the design and function of agricultural  
21 systems brings in ethical dimensions of agriculture, including how we treat the landscape,  
22 its resources, and each other. These are discussed in Chapter 11. The future of  
23 agroecology as it relates to better understanding and design of food systems is explored in  
24 Chapter 12, including a summary of the conclusions from the preceding chapters.

25 The evolution of agriculture in America brings us to a time that is the right time  
26 for using the concepts and tools that are emerging in our expansion of the field of  
27 Agroecology. The complex problems facing our global society with local and regional  
28 food shortages and environmental degradation will require approaches that integrate the  
29 environment, society, and ecology. We are being asked to develop a new ethic for  
30 agriculture, an ecological morality that will reflect our understanding of nature.  
31 Community-based problem solving and change within the landgrant universities are  
32 approaches that can be used. Regardless of the approach, our way of thinking has to be  
33 multi-dimensional.

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27  
 28 **Figure Captions**

29 Fig. 1. Grant Wood, *Plowing on Sunday*, 1934, ©Estate of Grant Wood/Licensed by  
 30 VAGA, New York, NY. Museum of Art, Rhode Island School of Design, Gift of Mrs.  
 31 Murray S. Danforth.

32  
 33 Fig. 2. Grant Wood, American, 1891-1942, *American Gothic*, 1930, oil on beaverboard,  
 34 74.3 x 62.4 cm, Friends of American Art Collection, All rights reserved by The Art  
 35 Institute of Chicago and VAGA, New York, NY, 1930.9341, reproduction © The Art  
 36 Institute of Chicago.

37  
 38 Fig. 3. Grant Wood, *Stone City, Iowa*, 1930, (JAM.1930.35), Joslyn Art Museum, Omaha,  
 39 Nebraska.

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 41 Fig. 4. Christian Petersen (American, 1885-1961), *Cornhusker*, 1941. Painted plaster, 43  
 42 x 16 x 24 inches. Christian Petersen Collection, Brunnier Art Museum. University  
 43 Museums, Iowa State University. Gift in memory of Joseph M. Coppola, Sr., by the  
 44 Coppola Family. UM99.329

- 1 Fig. 5. George Segal, *The Farm Worker*, 1962-63, ©The George and Helen Segal  
2 Foundation/Licensed by VAGA, New York, NY.  
3
- 4 Fig. 6. Children's drawings showing the progression in conceptual development.  
5
- 6 Fig. 7. Robert Hooke's representation of cork cells, *Micrographia: or Some*  
7 *Physiological Descriptions of Minute Bodies Made by Magnifying Glasses*, London,  
8 1665. Courtesy of Smithsonian Institution Libraries, Washington, DC.  
9
- 10 Fig. 8. Transmission electron micrograph of potato cells with starch granules. Courtesy of  
11 Michael W. Davidson.  
12
- 13 Fig. 9. Scanning electron micrograph of potato cell with starch granules. Courtesy of  
14 Institute of Food Research, United Kingdom.  
15
- 16 Fig. 10. Schematic description of future university for active learning and research, with  
17 student and faculty learning activities often in the farming environment, and close  
18 relationships with both natural resource and urban society contexts (from Lieblein,  
19 Francis, and King, 2000; reprinted with permission of *Journal of Agricultural Education*  
20 *& Extension*, Wageningen, Netherlands).

1 In a multidimensional context, the identification and aggregation of poverty are more complicated than in the uni-dimensional one. However, some of the axioms of the uni-dimensional context can be analogously extended to the multidimensional one (see, e.g., Tsui 2002; Bourguignon and Chakravarty 2003; Alkire and Foster 2007). This paper estimates multidimensional poverty in China applying the methodology developed by Alkire and Foster (2007) (hereafter "AF methodology"), which is a variant of that developed by Foster, Greer, and Thorbecke (1984) (hereafter referred to as "FGT"). The AF method of agroecology starts when I meet a farmer who would like to farm using agroecological principles. We work together, and always start by identifying which agroecological practices they already use. In the past, Cuban farmers practiced agroecology simply to improve their soils and to help one another. In recent years, as the movement has grown, these farmers have become conscious of the work they do and have started to collectively determine their own political processes. Self-reflection and self-determination are impacts of agroecology.