



Participatory Extension Approaches for Rural Development

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Rural development works best when rural people are seen not just as beneficiaries of technology but as competent collaborators in recognising issues, testing solutions and controlling local development. Participatory extension techniques evolved as an alternative to the traditional top-down agricultural extension system. In this system, suggestions were formulated by experts and then conveyed to farmers by extension agents. Instead participatory extension encourages a shared learning process between farmers, academics, extension workers, community institutions, markets and local authorities. Its main techniques include Participatory Rural Appraisal, Participatory Learning and Action, Farmer Field Schools, farmer-to-farmer extension, participatory technology development, farmer research networks, innovation platforms and participatory digital advisory systems. There is evidence from diverse locations that these tactics may improve farmers' knowledge, experimentation, problem solving, collective organization and confidence. They may also facilitate improved farm management, livelihood diversification, environmental protection, gender participation, local entrepreneurship and community resilience, under acceptable circumstances. And, importantly, engagement does not always lead to equal or sustainable results. Elite control, token consultation, exclusion of women and marginalised families, poor facilitation, limited institutional backing and short project cycles may diminish effectiveness. Participatory extension must be seen as a long-term process of co-determination and institutional transformation rather than as a set of field tools. This paper reviews the ideas and key models of participatory extension, its contributions, limits and practical needs and discusses how participatory extension might become a strong weapon for inclusive and sustainable rural development.

Introduction

Traditionally, agricultural extension has been connected with the dissemination of scientific knowledge from research institutes to rural communities. In the usual paradigm, the researchers develop technology, extension workers disseminate advice and farmers are expected to implement these recommendations. This paradigm facilitated the dissemination of better crop types, fertilisers, plant-protection measures and farm equipment. But it typically underestimated variability in rural landscapes, family resources, indigenous knowledge, local institutions and farmer priorities.

A proposal that has been created under controlled research settings may not be economically viable for a smallholder with limited acreage, inconsistent irrigation, limited manpower or poor market access. Farmers also handle a number of interlinked activities such as crops, animals, trees, family nutrition, employment, credit and social duties. Hence their choices cannot be explained just by yield maximisation. Participatory extension grew out of the understanding that rural people have important experience knowledge and need to be included in examining their situation, determining priorities and assessing alternative solutions.

One of the most prominent movements in this transformation was Participatory Rural Appraisal. It stressed a “reversal of learning” where experts learn from rural people, instead than just gathering information from them. In a similar vein, participatory research varies from traditional research in that impacted communities influence the process, interpretation and application of information rather than merely operating as respondents or experimental subjects (Chambers, 1994a, 1994b; Cornwall & Jewkes, 1995).

Thus participatory extension is more than just a better communication approach. It signifies transformation in the connection between farmers, researchers, extension workers and development organisations. Recommendations are tested in local contexts, farmers have more influence on choices that impact their livelihoods and knowledge is co-produced.

Understanding Participatory Extension

Participatory extension may be defined as a farmer-led process where rural people, extension experts and other stakeholders together identify needs, explore options, test alternatives, assess findings and take collaborative action. The extension worker becomes a facilitator, connection and learning partner instead of the exclusive authority. Participation is at several levels. At the lowest level the farmers may be only notified about a scheme. They may be consulted and their views gathered, but not given influence over ultimate choices. Functional participation implies farmers’ involvement in some actions required to accomplish a pre-defined project. Farmers are involved in analysis, planning, experimenting and assessment. Interactive engagement is more intense. The most powerful type is self-mobilization, when local people organise their own activities and/or demand outside help according to locally established goals. More than just attending meetings is needed for meaningful involvement. It indicates impact on decision-making, access to relevant information, acknowledgement of diverse types of knowledge and responsibility of involved institutions. For Cornwall and Jewkes, the key issue in participatory research is not so much which methodologies are utilised but rather who controls the generation of knowledge and the application of the information produced. Similarly, critiques of extension that followed have noted the use of participatory language to mask expert-driven programs where farmers are simply asked to support predetermined goals (Cornwall & Jewkes, 1995; Cook et al., 2021).

Core Principles

Respect for farmers’ knowledge

Farmers are constantly watching soils and crops, animals, weather, pests, availability of manpower and the behaviour of markets. Usually their expertise is very site specific and comes from a lot of experience. Scientific research includes rigorous testing, measurement and access to bigger bodies of knowledge. Participatory extension does not see scientific and local knowledge as opposing systems. It tries to integrate their own capabilities. According to Hoffmann, Probst and Christinck, farmer experimentation normally takes place in real production conditions, but formal scientific study may provide controlled comparison, analytical procedures and access to a greater range of information. These complementing advantages and contrasts in communication and power relations between farmers and scientists should be acknowledged as a pre-requisite for effective cooperation (Hoffmann et al., 2007).

Learning through experience

Participatory extension is based on observation, experimentation and reflection. Farmers learn best by comparing treatments, seeing improvements over time, discussing outcomes, and relating new knowledge to their own experience. This is especially relevant for more complicated techniques such as integrated pest control, soil-health improvement, water conservation and climate adaption, when fixed guidelines may not be acceptable.

Inclusion and equity

A village is not a socially homogenous entity. Problems may vary for landowners, renters, agricultural labourers, women, young people, livestock keepers, indigenous populations and resource-poor families. Participatory method must actively include those whose views are

often less prominent. Otherwise local elites may control meetings and divert funding to their interests.

Collective action

Many rural issues cannot be handled by the individual homes. Cooperation is required in watershed preservation, grazing management, irrigation maintenance, pest monitoring, common-property management, input buying, and collective marketing. Participatory extension encourages communities to build a shared concept, norms and organisational ability.

Continuous reflection

There should be recurrent cycles of preparation, activity, observation and revision throughout the participation. communities and facilitators need to be able to identify failed methods, adapt activities and learn from unanticipated consequences. Participation is therefore a continuing relationship rather than a one-off consultation process.

Major Participatory Extension Approaches

1. Participatory Rural Appraisal and Participatory Learning and Action

Participatory Rural Appraisal (PRA) is a collection of visual, group-based, field-oriented methods and instruments which allow rural people to assess their own situation. Commonly utilised tools include village resource maps, social maps, transect walks, seasonal calendars, historical timelines, livelihood diagrams, issue ranking, preference score, wealth categorisation and institutional link diagrams. The value of these tools resides not just in the information they create but also in the conversation they stimulate. For instance, a seasonal calendar may show that periods of feed scarcity, illness incidence, family debt and workforce shortages coincide. A village map might record residences that are far from water sources or are not irrigated. Matrix ranking may be used by farmers to assess crop types on the basis of yield, flavour, fodder value, drought tolerance, storage quality and market demand, rather than on a single scientific criteria. Chambers said PRA moves away from obtaining information to support local analysis. It also shifts communication from mostly verbal interviews to visual and comparison approaches that may be utilised by persons with varied levels of literacy. But facilitators should not hurry, dominate talks or use PRA only to legitimate choices previously made by a project.

2. Farmer Field Schools

Farmer Field Schools are group-based, season-long learning procedures where farmers monitor a crop, livestock operation or agroecosystem on a regular basis. Participants carry out field experiments, evaluate management choices, assess findings and make decisions together. The field itself becomes the major reservoir of learning. This strategy became connected with integrated pest control since farmers had to understand ecological linkages rather than just following schedules for applying pesticides. A good field school examines crop development, insect populations, beneficial species, soil conditions and weather. They talk about the causes of the issue and assess whether assistance is needed. Positive benefits on knowledge, farm-management practices and, in numerous situations, productivity, income, food security and farmer empowerment have been documented in research. East Africa studies indicated that involvement was connected with gains in output and revenue for various kinds of farmers. Research in Tanzania found advantages extended beyond the local agricultural business to food security and poverty alleviation. Participation in field schools has also been associated with increased confidence, collective action and capacity to work with service providers. Evidence is not always positive. Evaluation of farmer field schools in Indonesia indicated minimal dissemination of sophisticated information from taught farmers to non-participants and highlighted doubts about cost-effectiveness at scale. Other research showed knowledge impacts greater than productivity gains. These discrepancies suggest that results rely on the quality of training, the competency of the facilitator, local relevance, time, participant selection and follow-up assistance.

3. Participatory Technology Development

Participatory technology development brings farmers and scientists together to create, test and improve alternatives for agriculture. Farmers might be involved in choosing research issues, choice of remedies, organising trials, collecting observations and appraising findings. The aim is not to show off a polished technology but to find solutions adapted to local situations. A farmer may assess a crop variety for grain output but also for time of maturity, quality of fodder, culinary features, resistance to storage pests and compatibility with intercropping. In a similar way, a livestock technology may be assessed in terms of feed availability, labour needs, veterinary expenditures and risk. Participatory assessment consequently broadens the criterion for technological development. Clarity of roles and rewards is essential for successful cooperation. Farmers need to know what trials are for, and the observations they make must be allowed to affect findings. Researchers also have to ensure enough experimental rigour. Participatory research is greatest when scientific reliability and practical relevance are seen as complementing rather than competing goals.

4. Farmer Research Networks

Participatory experimentation is not limited to a few demonstration farms in farmer research networks. Many farmers try out possibilities under varied situations, generating locally relevant observations, and share the results via organised networks. Researchers contribute to the design and analysis of the trials, while farmers give their knowledge of the setting and practical judgement. These networks are especially beneficial in areas where the circumstances for farming vary substantially across soils, rainfall patterns, household resources and market settings. Rather of seeking for one “best” technology, the network determines what works effectively for certain farmers in specific conditions. The acquisition of digital data may help aggregate outcomes while keeping farmers in charge of the experiments. Nelson, Coe and Haussmann presented farmer research networks as a mechanism for matching varied agricultural alternatives with diverse smallholder environments. Such an approach may increase both local learning and the external validity of agricultural research but only if farmers remain active experimenters, not unpaid data collectors.

5. Farmer-to-Farmer Extension

The farmer-to-farmer extension involves experienced farmers, community resource people or volunteer farmer-trainers to pass on their expertise to other farmers. Local trainers are likely to be successful since they speak the language of the community, know the local production methods and are accessible after official programs are over. It may also be easier for farmers to talk about setbacks and financial restrictions with colleagues. This is a reasonably low-cost way of extending regional coverage, but should not be seen as free work. Volunteer trainers suffer expenses of time, travel and opportunity. Ongoing participation may rely on training possibilities, recognition, access to technical help, social status or income-generating prospects. Research in Kenya suggests that volunteer farmer-trainers can see their job as an investment in personal, social and financial capital. But the longevity of the plan depends on sustained technical backstopping and adequate incentives. Selection methods should also provide equitable possibilities for women, young farmers, tenants and impoverished families to become trainers (Kiptot & Franzel, 2014).

6. Agricultural Innovation Platforms

Agricultural challenges are not just affected by production expertise. Farmers may adopt an improved method but still be limited by scarce seed, costly finance, bad roads, inadequate processing facilities or unreliable markets. Innovation platforms bring together farmers, researchers, extension agencies, input suppliers, dealers, financial institutions, processors, civil-society organisations and government departments to overcome such interrelated constraints. An innovation platform may coordinate quality seed production, negotiate with customers, promote local processing, increase access to veterinary services or influence administrative processes. Its aim is to facilitate institutional and organisational innovation and technological transformation. In West Africa, there is evidence that innovation platforms may

challenge constraining institutional structures and develop new linkages among players. But their effectiveness rests on facilitation, representation, leadership and the capacity to go from conversation to coordinated action. Platforms may also reinforce existing power imbalances if dominant agendas are driven by powerful organisations (Hounkonnou et al., 2018). Scaling via innovation platforms is not only a question of disseminating a successful package. In Rwanda, research indicated that scaling entails interaction between actors advocating innovations and actors adopting, demanding or altering them. Sustainable scaling hence needs institutional support, local adaptation and feedback rather than numerical increase alone (Totin et al., 2020).

7. Participatory Digital Extension

Agricultural extension is rapidly using mobile phones, messaging apps, digital platforms, films, sensors and online advisory services. But access alone does not make a digital service participatory; farmers must also be able to access it. Too many platforms are still developed by technical professionals who have little grasp of users' literacy, language, connectedness, gender relations and decision-making settings. Participatory digital design engages farmers in identifying the issue, testing the prototype, rating its usability and making decisions on how data will be gathered and shared. Farmers mention demands that designers miss such as voice-based information, offline access, local crop names, images for diagnosis, transparent sources and the opportunity to dispute advice. Steinke et al. showed that participatory design may increase the practical applicability of digital agriculture innovation. But digital engagement must tackle uneven access to cellphones, internet connection, digital skills and management of family devices. It should also respect farmers' data and not substitute vital interpersonal extension with automated messaging (Steinke et al., 2022).

Contribution to Rural Development

Improved knowledge and decision-making

Participatory extension builds farmers' ability to observe, assess and experiment. This is more sustainable than memorising advice, since farmers may react to new pests, shifting rainfall, market changes and resource limits. The upshot is not only technological adoption, but increased decision-making capacity.

Livelihood and economic benefits

Locally adapted technology may increase production, eliminate wasteful inputs spending and boost diversification. Group organisation may also increase access to capital, inputs, processes and markets. But there are no guarantees on economic gains. The labour needs or risk or market circumstances may be such that a technically effective approach is nonetheless unappealing.

Social capital and collective organization

Regular group meetings of farmers may help them create trust, mutual support and networks. These partnerships enable communities to share work, manage shared resources, get services and negotiate with outside organizations. Later on, the participating groups may engage in activities outside the initial expansion theme such as savings, marketing, seed production or community activism.

Empowerment and leadership

Empowerment is when rural people develop confidence, analytical skills and leverage on institutions. Research on farmer field schools in East Africa identified connections between participation, empowerment and well-being. Participants said they felt more confident in talking to service providers and participating in communal activities (Friis-Hansen & Duveskog, 2012).

Gender inclusion

Participatory groups may provide women with opportunity to acquire technical expertise, develop leadership skills and challenge limiting conventions. Research in Kenya indicated that farmer field schools resulted in improvements in learning and gender relations in some of the communities included. But involvement may also raise women's labour burden or keep family decision-making unaltered. Hence, there is a need for gender-responsive scheduling,

childcare accommodations, female facilitation, secure speaking chances and attention to control over income (Najjar et al., 2013).

Environmental management and climate resilience

Knowledge intensive approaches, not set input recipes, are typically required for sustainable agriculture. Participatory experimentation may allow farmers to understand soil fertility, crop diversification, biological pest control, water management and agroecological linkages. In Malawi, participatory climate research indicated that farmers' own observations and informal networks were more relevant sources of adaptation information once they participated in agroecological experiments (Bezner Kerr et al., 2018).

Challenges and Limitations

- The first issue is getting tokens to play with. Organisations might welcome farmers to meetings but keep control of priorities, funds and assessment. Taking part in these situations is a way of accepting a programme that has been created elsewhere.
- The second is the power imbalance in communities. Those who are more educated, richer or more politically connected may control discourse. Women from marginalised families could be present but unable to shape choices. Separate discussions may be needed, and rigorous grouping and open selection methods may be needed.
- Third, participatory techniques are heavily facilitation-based. Good facilitators listen, handle disputes, bring in the quieter players, clarify technical knowledge and maintain analytical quality. Weak facilitation may turn field schools or PRA activities into conventional lectures.
- Fourth, involvement takes time. Farmers might suffer large opportunity costs, especially in peak agricultural seasons. Repetitive meetings with no evident rewards may be tiring. Programmes should be sensitive to local calendars and link learning to practical imperatives.
- Fifth, local knowledge is helpful, but not always full or correct. There are misconceptions among farmers and scientists alike. Participatory extension should permit respectful testing, not romanticise either scientific or indigenous knowledge.
- Lastly, scalability is a big problem. Small, well-funded programs may provide spectacular results that cannot be sustained when hastily scaled up. Farmer field schools provide evidence that quality of facilitators, prices, and transmission of information may weaken with scale. Thus, participatory techniques must be institutionalised, without becoming rigid or mechanically standardised. Reviews of agricultural extension point to the need to keep human connections, dignity, care and farmer agency paramount throughout institutional development (Cook et al., 2021).

Strengthening Participatory Extension in Practice

A good program should begin with inclusive diagnosis, not with a pre-determined technology. Farmers should be helped to set priorities but information should be obtained from diverse social and livelihood groups. The method should differentiate between issues that can be solved via knowledge and those that need financing, infrastructure, market change or regulatory intervention. Objectives and decision-making duties must be clear. Participants need to know which choices are theirs to make, which are shared, and which are the responsibility of public authorities or funding agencies. Broken pledges undermine confidence. Facilitators need to be trained in adult education, group dynamics, gender sensitivity, conflict management, participatory assessment and technical disciplines. They should be judged not only on the number of meetings conducted but on the quality of learning, inclusivity and local action. Local experimentation has to be well recorded. "Farmers can use simple record sheets, photographs, field maps, scoring methods or voice recordings". Researchers may help with trial design and analysis, but ensure documentation is still accessible and valuable to participants. Programmes should integrate approaches PRA may be used for diagnostics, farmer field schools for learning by experience, farmer research networks for larger experimentation, farmer to farmer extension for dissemination and

innovation platforms for addressing institutional or market restrictions. There is no one approach which is adequate for every case. Monitoring should encompass human and societal outcomes as well as adoption and yield. Relevant indicators may include problem solving abilities, women's involvement, quality of group choices, continuance of experiments, collective marketing, access to institutions and confidence in dealing with authorities. In an evaluation of a climate-friendly participatory extension project (Knook et al., 2020), social learning, resilience and decision-making outcomes were shown to be essential as well as the adoption of suggested practices. Institutional support for the long term is necessary. Once individual initiatives are completed, farmer groups require access to updated technical advice, labs, meteorological information, markets and financial services. Durable relationships should be developed between public extension systems, universities, research institutes, cooperatives, producer organisations and civil-society groups.

Relevance for Rural Development in India

Participatory extension is of tremendous significance to India as the agricultural circumstances vary widely between agro ecological zones, farm sizes, caste and tribal people, irrigation problems and market settings. It is not expected that standard advice will apply to any of these situations. Participatory principles may be used by Krishi Vigyan Kendras, Agricultural Technology Management Agencies, state agricultural colleges, farmer-producer organisations, self-help groups, cooperatives, panchayats and rural development agencies to boost their initiatives. Village level diagnoses may uncover issues of local importance, and farmer field schools and on-farm experimentation can modify suggestions. Producer organisations and innovation platforms may assist in dealing with input supply, processing, branding and marketing restrictions. The participation should include small and marginal farmers, tenant cultivators, woman farmers, livestock keepers, rural youth and agricultural labour families. Digital extension should complement, not replace, local facilitators and field demonstrations. Communication in local languages, voice based services and systems for farmer input are also vital.

Conclusion

Participatory extension changes agricultural extension from a one-way transmission of technology to one of collaborative learning, experimentation and action. Its relevance for rural development comes in its potential to combine technical improvement and empowerment, collective organization, environmental management, institutional access and livelihood resilience. Participation, however, should not be a fashion label or a series of visual tasks. Success relies on the distribution of decision-making authority, quality of facilitation, participation of marginalised groups, scientific integrity, institutional commitment and continuity of support. Participatory projects should also recognise that rural development concerns include markets, infrastructure, finance, governance, social inequalities as well as agricultural knowledge. Respecting rural people as analysts, experimenters and development partners makes extension more relevant and answerable. Participatory extension is therefore more than a way to increase technology adoption. It is a road for rural communities to increase their ability to recognise change, engage with institutions and design their own development.

References

1. Bezner Kerr, R., Nyantakyi-Frimpong, H., Dakishoni, L., Lupafya, E., Shumba, L., Luginaah, I., & Snapp, S. S. (2018). Knowledge politics in participatory climate change adaptation research on agroecology in Malawi. *Renewable Agriculture and Food Systems*, 33(3), 238–251. doi: 10.1017/S1742170518000017
2. Bruges, M., & Smith, W. (2008). Participatory approaches for sustainable agriculture: A contradiction in terms? *Agriculture and Human Values*, 25, 13–23. doi: 10.1007/s10460-007-9058-0

3. Chambers, R. (1994a). The origins and practice of participatory rural appraisal. *World Development*, 22(7), 953–969. doi: 10.1016/0305-750X(94)90141-4
4. Chambers, R. (1994b). Participatory rural appraisal: Analysis of experience. *World Development*, 22(9), 1253–1268. doi: 10.1016/0305-750X(94)90003-5
5. Cook, B. R., Satizábal, P., & Curnow, J. (2021). Humanising agricultural extension: A review. *World Development*, 140, 105337. doi: 10.1016/j.worlddev.2020.105337
6. Cornwall, A., & Jewkes, R. (1995). What is participatory research? *Social Science & Medicine*, 41(12), 1667–1676. doi: 10.1016/0277-9536(95)00127-S
7. Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development*, 40(2), 402–413. doi: 10.1016/j.worlddev.2011.05.019
8. Feder, G., Murgai, R., & Quizon, J. B. (2004). Sending farmers back to school: The impact of farmer field schools in Indonesia. *Review of Agricultural Economics*, 26(1), 45–62. doi: 10.1111/j.1467-9353.2003.00161.x
9. Friis-Hansen, E., & Duveskog, D. (2012). The empowerment route to well-being: An analysis of farmer field schools in East Africa. *World Development*, 40(2), 414–427. doi: 10.1016/j.worlddev.2011.05.005
10. Godtland, E. M., Sadoulet, E., de Janvry, A., Murgai, R., & Ortiz, O. (2004). The impact of farmer field schools on knowledge and productivity: A study of potato farmers in the Peruvian Andes. *Economic Development and Cultural Change*, 53(1), 63–92. doi: 10.1086/423253
11. Hoffmann, V., Probst, K., & Christinck, A. (2007). Farmers and researchers: How can collaborative advantages be created in participatory research and technology development? *Agriculture and Human Values*, 24, 355–368. doi: 10.1007/s10460-007-9072-2
12. Hounkonnou, D., Brouwers, J. H. A. M., van Huis, A., Jiggins, J., Kossou, D., Röling, N., Sakyi-Dawson, O., & Traoré, M. (2018). Triggering regime change: A comparative analysis of the performance of innovation platforms that attempted to change the institutional context for nine agricultural domains in West Africa. *Agricultural Systems*, 165, 296–309. doi: 10.1016/j.agsy.2016.08.009
13. Kiptot, E., & Franzel, S. (2014). Voluntarism as an investment in human, social and financial capital: Evidence from a farmer-to-farmer extension program in Kenya. *Agriculture and Human Values*, 31(2), 231–243. doi: 10.1007/s10460-013-9463-5
14. Knook, J., Eory, V., Brander, M., & Moran, D. (2020). The evaluation of a participatory extension programme focused on climate-friendly farming. *Journal of Rural Studies*, 76, 40–48. doi: 10.1016/j.jrurstud.2020.03.010
15. Larsen, A. F., & Lilleør, H. B. (2014). Beyond the field: The impact of farmer field schools on food security and poverty alleviation. *World Development*, 64, 843–859. doi: 10.1016/j.worlddev.2014.07.003
16. Najjar, D., Spaling, H., & Sinclair, A. J. (2013). Learning about sustainability and gender through farmer field schools in the Taita Hills, Kenya. *International Journal of Educational Development*, 33(5), 466–475. doi: 10.1016/j.ijedudev.2012.06.004
17. Nelson, R., Coe, R., & Haussmann, B. I. G. (2019). Farmer research networks as a strategy for matching diverse options and contexts in smallholder agriculture. *Experimental Agriculture*, 55(S1), 125–144. doi: 10.1017/S0014479716000454
18. Pretty, J. N. (1995). Participatory learning for sustainable agriculture. *World Development*, 23(8), 1247–1263. doi: 10.1016/0305-750X(95)00046-F
19. Röling, N., & van de Fliert, E. (1994). Transforming extension for sustainable agriculture: The case of integrated pest management in rice in Indonesia. *Agriculture and Human Values*, 11(2–3), 96–108. doi: 10.1007/BF01530451
20. Steinke, J., Ortiz-Crespo, B., van Etten, J., & Müller, A. (2022). Participatory design of digital innovation in agricultural research-for-development: Insights from practice. *Agricultural Systems*, 195, 103313. doi: 10.1016/j.agsy.2021.103313

21. Totin, E., van Mierlo, B., & Klerkx, L. (2020). Scaling practices within agricultural innovation platforms: Between pushing and pulling. *Agricultural Systems*, 179, 102764. doi: 10.1016/j.agry.2019.102764
22. van den Berg, H., & Jiggins, J. (2007). Investing in farmers: The impacts of farmer field schools in relation to integrated pest management. *World Development*, 35(4), 663–686. doi: 10.1016/j.worlddev.2006.05.004