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Community-Based Grassland Management in Western China

Rationale, Pilot Project Experience, and Policy Implications

Grassland degradation in China is widely perceived to be accelerating, and the blame is often placed by government officials and researchers on a supposed “tragedy of the commons.” Grassland policy seeks to address

this through the establishment of household tenure and the derivation and external enforcement of household stocking rates. Drawing upon the authors’ field research at a number of sites in western China, this article argues that the actual tenure situation is not as open access as is commonly implied and that existing forms of community-based management (including collective and small group tenure) are advantageous, given the socioeconomic and ecological context. Among other things, community-based management can facilitate low-cost external exclusion, economies of size in herd supervision, equal access to pastoral resources, the mitigation of environmental risk, and the prompt resolution of grassland-related disputes. Recent innovative attempts to both improve and formalize collective and group tenure arrangements indicate that there is a wide range of different possible grassland tenure-management models available, in addition to the household tenure–household management model emphasized in grassland policy. China’s revised Grassland Law (2003) arguably provides legal space for these alternative models. However, for the future of community-based grassland management to be secure, implementing agencies need to be more aware of these alternative models and have the willingness and capacity to adopt a flexible and participatory approach to grassland policy implementation.

Keywords: China; Xinjiang; Tibetan Plateau; grassland policy; grassland management; land tenure; common property.

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Introduction

This article begins by outlining Chinese grassland policy in the reform period and the rationale underpinning it. The fieldwork on which this article is based comes from the authors’ involvement with various research and development projects at different sites on the Tibetan Plateau (within Sichuan and Yunnan Provinces and the Tibetan Autonomous Region [TAR], Figure 1)

and Xinjiang Uygur Autonomous Region. The next section introduces these projects and sites, as well as the methodology used, before key characteristics of local-level arrangements for grassland management are distilled. Considerable differences between grassland policy and local-level arrangements are found, and the following section explains the local arrangements in terms of the social, ecological, and economic context. The case is put forth that although the existing forms of community-based management are not without problems, institutional change should be based on their improvement, and recent attempts of this kind are discussed. Finally, developments in the legislative framework for grassland tenure are examined, before conclusions are drawn in the last section.

Grassland policy in the reform period

China’s rural reforms, initiated in its cropland regions in the late 1970s, spread to all its pastoral regions by the early 1980s. Central to the initial reforms was the replacement of the commune system with the household responsibility system, under which households were granted greater autonomy with respect to farm management. In pastoral regions, former commune livestock were distributed in ownership to households, production quotas were reduced, and livestock product marketing channels liberalized. After meeting obligations for government taxes and fees, households have since been entitled to residual income.

With the dismantling of the commune system in the early 1980s, grasslands were typically allocated to whole villages or groups of households, varying in size from several hundred households to just a few. The area of pasture assigned to groups was crudely based on the number of commune livestock distributed to their constituent households at the time, which in turn depended on their household population or labor force. The legal and regulatory framework for grassland tenure has been evolving, with the 1985 Grassland Law providing an overarching (though somewhat ambiguous) framework. Subsequent regulations issued by the Grassland Division of the Central Office of the Ministry of Agriculture in Beijing, and provincial implementing regulations, have since provided more specific guidance.

Certain key features of grassland policy in the reform era can be identified. First, all grasslands continue to be owned by the state or collective. Although the term “collective” is not well defined in law (Ho 2000), in practice it is generally interpreted to be the administrative or natural village. Second, long-term (typically 50-year) use rights to grasslands are to be assigned to individual households, via grassland-use certificates and contracts. Households are required to pay fees for these rights, which are calculated on the basis of the seasonal type and area of pasture contracted, although in many



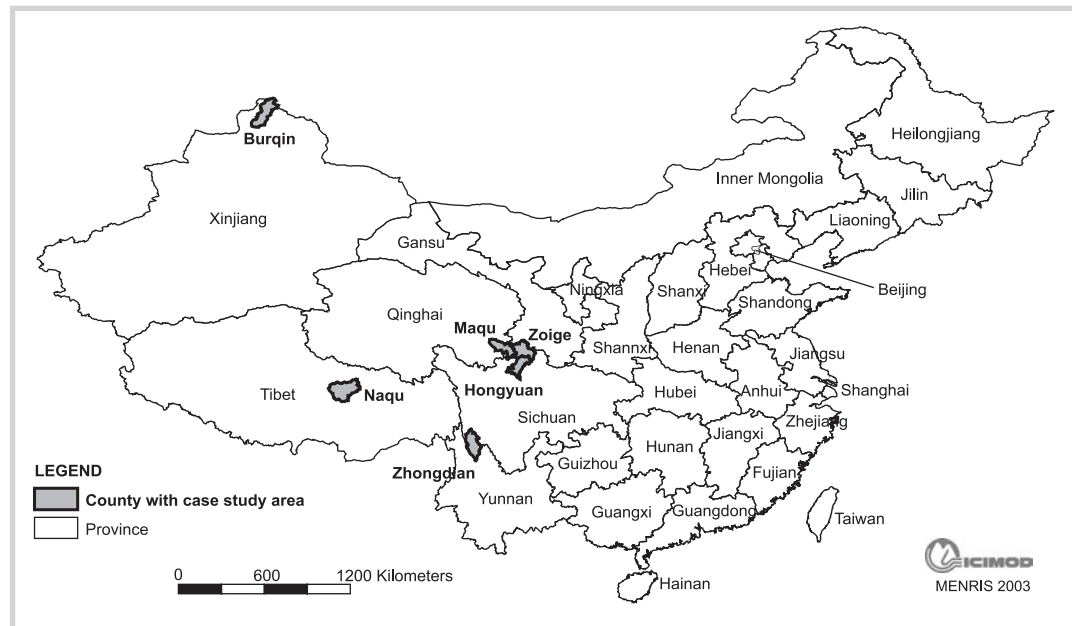


FIGURE 1 Location of the counties in which case studies were conducted. (Map courtesy of ICIMOD)

areas households to date have never been charged for using their contracted grasslands (eg, in Maqu County, Gansu Province). Policy also prescribes the derivation of stocking rates for household pastures and the implementation of sanctions to deter overstocking.

The official rationale underpinning Chinese grassland policy is that through the assignment of grassland-use rights to the individual household level, pastoralists will be given the incentive to stock their grasslands within biophysical limits and to invest in grassland improvements. Although post-1978 rural reforms have had a positive impact on pastoral incomes, it is widely perceived by Chinese policy makers and researchers that the sustainability of these gains is being threatened by accelerating grassland degradation. They have estimated that some 90% of China's grasslands, which account for 40% of its total territory, are now degraded to some degree, including 42% moderately to seriously (SDPC 1996; SEPA 1998). Furthermore, policy makers and researchers perceive overstocking to be the principal proximate cause of grassland degradation; overstocking in turn is related to the classic "tragedy of the commons" (Longworth 1990; NRC 1992; Longworth and Williamson 1993; Tuoman 1993; Wang 1995; Miller 1999). This informs their conclusion that individual household tenure needs to be established. It should be noted that both the extent and causes of grassland degradation in China are contested, with some arguing that neither degradation nor overstocking is nearly as widespread and serious as received wisdom suggests (Miller 1999; Ho 2001). However, this article will not directly engage in this debate but instead will focus on the institutional dimension of grassland management.

According to official statistics, the contracting of grassland-use rights to individual households is almost complete in most of the major pastoral provinces. Use rights to some 79% of total useable grassland in Inner Mongolia (Inner Mongolia Animal Husbandry Bureau [AHB], 1990 data) and 94% of total useable grassland in Xinjiang (Xinjiang AHB, 1999 data) have been assigned to individual households. However, official statistics on the proportion of grassland that has been contracted need to be treated with caution (Ho 2000). As will be discussed in the next section, the issuance of grassland-use contracts in many parts of western China is still in progress and has not necessarily been synonymous with the establishment of individual household boundaries in grasslands. This failure to effectively establish household tenure in China's extensive grasslands, more than 2 decades after the initiation of rural reforms, contrasts sharply with the case of cropland areas, where household tenure was virtually established overnight. Furthermore, in cases where household pastoral tenure has been established, the proposed benefits have frequently not materialized (Williams 1996; Bedunah and Harris 2002; Richard 2002).

Case studies and methodology

There have been very few empirical studies of local-level institutional arrangements for grassland management in China or of the process and impact of grassland policy implementation. The remainder of this article draws upon fieldwork with which the coauthors have been involved at various sites in western China (see Figure 1). There was some variation in the pur-

FIGURE 2 Coauthor Yan Zhaoli undertaking participatory action research with Tibetan pastoralists, Hongyuan, Sichuan. (Photo by Gao Jingfu)



pose, scope, and timing of the fieldwork undertaken at the different sites. The fieldwork undertaken by Tony Banks in Burqin County, Xinjiang, was doctoral research and involved prolonged visits to 3 Kazakh communities in 1998 and 2000 (Banks 2003). Camille Richard's fieldwork in Naqu County, Tibet Autonomous Region, was for planning a community-based rangeland rehabilitation project in 2 communities and involved 2 site visits in 2002. Her fieldwork in Zhongdian County, Yunnan Province, was related to the implementation of a local pasture development project and conservation planning (Xie et al 2002). Li Ping also undertook fieldwork in Zhongdian County, but as part of a larger policy study on rural land tenure to inform the drafting of new land tenure legislation (Li et al 2002). Camille Richard's and Yan Zhaoli's research in Maqu County, Gansu Province, and Zoige and Hongyuan Counties, Sichuan Province (Figure 2), was related to an ongoing action research policy initiative sponsored by the International Centre for Integrated Mountain Development (Du G 2002; Yan et al 2002). Finally, the article also draws on fieldwork findings from participatory planning and implementation exercises undertaken for Oxford Famine Relief (OXFAM) with pastoralists in Maqu County (Zhao and Tang 2002).

The different studies share the common objective of gaining an understanding of institutional arrangements for grassland management. They also have used similar methodology, principally methods of rapid or participatory appraisal, including semistructured interviews with key informants, groups, and households; visual—particularly mapping—exercises; and direct observation. Some of the field research, including that undertaken in Burqin County, Xinjiang, also involved

the use of surveys. For more specific details regarding the case studies and methodologies used, the reader is referred to the relevant references cited in this article.

Contemporary local-level arrangements

A first feature of institutional arrangements found in the field is the persistence of collective and group tenure arrangements, despite attempts to allot to individual households. In many parts of western China, individual household tenure in rangelands remains the exception rather than the rule. When former commune rangelands were distributed in the early 1980s, the general pattern was for pastures to be allocated to the administrative or natural village ("collective tenure") or to small groups of often kin-related households ("group tenure"). Collective or group tenure arrangements have persisted across most regions and seasonal pastures. In Xinjiang, for example, group tenure arrangements were established in 1985 and although some of the original groups have subdivided, the average size of the groups has increased due to population growth (Banks 1999, 2001, 2002). Likewise in Tibet, rangelands have mainly been allocated to whole villages or groups of kin-related households, and these arrangements have largely persisted. However, there is an emerging trend for households to subdivide and fence winter and winter-spring pastures in the vicinity of their winter bases, especially in areas where extension inputs and government subsidies have been pervasive (eg, in Damxung County, TAR). This trend has also been noted in the Qinghai portion of the Tibetan Plateau (Miller 1999). In western Sichuan, summer pastures were originally allocated to groups of households and winter pastures to individual households, and this situation has persisted, although in some pilot areas, households have been assigned 1 parcel for year-round grazing (Yan et al 2002). Yunnan differs from other areas in that collective use of grasslands occurs at the administrative village level, but winter hay fields have been allocated near farmland, although management of these allotments has failed in many areas (Xie et al 2002). De facto arrangements are such that summer pastures are used in common by the whole administrative village, whereas winter pastures are only used in common by the smaller natural village unit. Across all study sites, individual tenure has only successfully been established in hayfields and artificial pasture.

A second feature of institutional arrangements is effective exclusion at the village level. In all case study areas, village boundaries in pasture are monitored and enforced by the local households using the grassland. In northern Xinjiang, villages pay 1 or several of their households to reside all year round in those seasonal pastures that are vulnerable to encroachment, thus pro-

tecting them from out-of-season encroachment by nonvillage members. During the season of use, both external and internal (group) boundaries in seasonal pastures are monitored and enforced by herders in the field. It should be noted that external exclusion at both the collective and group pasture levels has been established without boundaries being fenced. In the other case study areas, external exclusion is also achieved through a combination of designated grassland protection households, herders in the field, and, particularly in the case of winter pasture, households that reside in close proximity to the resource. Another closely related dimension of exclusion is seasonal exclusion. Local AHBs have established times for movement between different seasonal pastures, and these times are fairly effectively monitored and enforced by village leaders, who have the authority to fine violators.

A third dimension of institutional arrangements for grassland management is the presence of both formal and informal mechanisms for the resolution of disputes over grazing rights. Formal institutions for the arbitration of such disputes include the local AHB and People's Court, with the former being particularly concerned with disputes at the intervillage level and above. Pastoralists reserve the right to bring intravillage disputes to these formal forums for arbitration, but in practice, just about all such disputes at this level are resolved through the mediation of village leaders. This trend is slowly changing where individual allotments have been more strongly promoted. In Sichuan, more herders are actually going to the county AHB, Court, or Government for official demarcation of their private boundaries, indicating an increase of conflicts over land-use rights.

A fourth feature of institutional arrangements is the lack of internal regulation at the collective or group pasture levels. The need for internal regulation is suggested by the common perception of pastoralists that, in some seasonal types of pastures, livestock numbers are exceeding carrying capacity and that long-term grassland degradation is occurring. Villages and groups lack explicit mechanisms for determining how many livestock (or sheep equivalents) each household can graze on shared pasture. According to rangeland policy, stocking rates for pastures should be derived, monitored, and enforced by local AHBs. However, although official stocking rates have been derived for some regions, they are not monitored and enforced by the state, village, or pasture groups. The lack of internal regulation also equates with a lack of equal appropriation. Although households are hypothetically entitled to a share of the pasture on the basis of their household population and labor force in the early 1980s (when commune pastures were originally distributed to groups), considerable disparities in household herd

sizes have since developed, and these can only be partly explained by life-cycle factors. Thus, although hypothetical entitlements to pasture are relatively egalitarian, household herd sizes are not, and those households with large herds are appropriating a disproportionate share of collective or group pasture.

The case for community-based arrangements

The local-level arrangements for grassland management described in the previous section are molded by the economic, social, and ecological realities of pastoralism in western China. Rangelands are by nature extensive, of low productivity per unit of area, and spatially and temporally variable. This makes the net benefit of establishing private exclusion through fencing marginal at best, which is reflected in the frequent comment of pastoralists that even if they wanted to fence their pastures, they could not afford to. Instead, exclusion is more economically achieved through a combination of collective or group tenure arrangements, which are associated with shorter boundaries to be monitored and enforced, the direct observation of herders in the field, and the stationing of grassland protector households to ensure seasonal exclusion. Collective and group tenure arrangements also facilitate group-herding arrange-



FIGURE 3 Group-herding arrangements make possible economies of size with respect to herd supervision. Illustrated is a Kazakh herding group in spring–autumn pasture, Burqin, Xinjiang. De facto collective tenure persists in this pasture in part because of its patchy nature and the related difficulty of subdividing it equitably between groups or households. (Photo by Tony Banks)

TABLE 1 Formal and de facto grassland management units. (Source: authors' case studies and literature review)

Formal unit of grassland contract	Actual Management Unit		
	Household	Group	Collective
Household	Grassland contract with individual household Management by individual household <i>Case Study: Hongyuan County, Sichuan</i>	Grassland contract with individual household Management by group <i>Case Study: Maqu County, Gansu</i>	Grassland contract with individual household Cooperative of individual contract holders for pasture or landscape management <i>Case Study: Zhongdian County, Yunnan</i>
Group	—	Grassland contract with group Management by group <i>No documented case study</i>	Grassland contract with group Cooperative of groups for pasture or landscape management <i>No documented case study</i>
Collective	—	—	Grassland contract with collective (no internal land division) Management by collective <i>Case Study: Naqu County, TAR</i>

ments between households, which in turn enable the realization of economies of size in herd supervision (Figure 3).

A third benefit associated with collective and group tenure is that it facilitates equal access to pastoral resources, particularly when the distribution of forage and water across a given terrain is patchy. Pastoralists in all study sites were reluctant to have to subdivide their pastures because they feared that it would be difficult to do it (impartially), and it would exacerbate disputes between households. The concern for equal access has to be understood in the context of the broader environment, characterized by an absence of nonpastoral sources of livelihood or social welfare. In such an environment, guaranteed access to pasture constitutes an important source of social insurance for both existing and new pastoral households.

A fourth factor underlying community-based management is that it facilitates flexibility and mobility. Flexibility and mobility are important in arid to semi-arid regions, such as western China, which have high spatial and temporal variability in the distribution of rainfall, and thus forage, and are also exposed to climatic extremities such as droughts and snowstorms.

Thus, in northern Xinjiang, during severe snowstorms those households with winter pastures in the mountains are allowed to temporarily relocate their livestock to lower winter pastures on the desert basin and group boundaries in the latter are readjusted to allow for this. Community authority and collective “ownership” make such contingency arrangements possible. More generally, collective tenure facilitates equal access to temporally and spatially variable forage resources. Finally, with respect to dispute arbitration, the resolution of the vast majority of intravillage disputes by community-based mechanisms exemplifies their superiority in terms of speed and cost compared with more formal dispute arbitration mechanisms.

The presence of collective and group tenure arrangements in China’s western rangelands, coupled with local-level arrangements for ensuring external exclusion and the resolution of disputes, indicates a significant degree of community-based management. However, community-based management is not supported by the current legal and regulatory framework, which emphasizes household tenure and grants the local state rather than community authority over such matters as dispute arbitration and stocking rate regulation. Con-

temporary community-based management also has potential weaknesses, including its association in some areas with resource overuse and unequal appropriation. In the next section successful attempts to improve community-based management are documented.

Improving collective and group tenure: Case studies

Given the advantages—under current socioeconomic and ecological conditions—of community-based arrangements for grassland management, possible pathways to their improvement need to be considered. During the past half-decade, there have been several innovative pilot projects to improve collective and group tenure arrangements. A key characteristic of these pilot projects has been the adoption of a participatory approach involving pastoral communities, local government officials, and, in some cases, outside organizations. The projects have involved a range of different grassland contracting and managerial arrangements, a typology of which is presented in Table 1. The “formal unit of grassland contract,” given in the model developed in Table 1, refers to the unit (household, group, or collective) that the grassland is

formally contracted to. The “actual management unit,” in contrast, is the unit that is actually managing and using the grassland. In this sense, the actual management unit can alternatively be thought of as the unit of de facto tenure. Management arrangements that involve households or groups pooling their individually contracted grasslands together may be formal (if they have a formal agreement regarding joint use) or informal. It should be noted that there are a number of possibilities other than the household tenure–household management model that is emphasized in grassland policy, including household tenure–group management and collective tenure–collective management. Case studies of these alternative approaches are discussed below; for a case study of the implementation of the household tenure–household management model see Richard (2002).

Collective tenure and management

The Naqu County government of the TAR, with financial support from the Tibet Poverty Alleviation Fund, has established a number of fattening pastures that have been formally contracted to the village (either administrative or natural) as a whole. The location of boundaries was decided through consultation with com-

FIGURE 4 The fencing of swamp grassland in Naqu, Tibet, represents a case of a collective tenure and management regime. Household access to the fattening pastures resulting from such an arrangement is effectively controlled by the collective. (Photo by Camille Richard)



munities at the natural and administrative village levels, and boundaries have been fenced in those areas, particularly marshlands, where this represents a sound managerial tool. Rules for the use of the collective pastures, including stocking rates and timing of grazing, have been set by the village government. The rules regarding household access to the collective pastures vary from site to site, with criteria including household labor contribution and the number of livestock per household.

The further implementation of policy via grassland contracting will start in 2003, and the outcome in terms of the formal unit of tenure and actual management regime is indeterminate. It is planned to formally contract winter pastures to individual households, with the area being assigned depending on household population (70%) and livestock numbers (30%). To ensure equitable distribution, grasslands will be graded according to their quality, and each household will be assigned a portion of the different grade of grassland. A lottery will determine which specific parcels of grassland are allocated to each household. According to government officials, using the above formula favors poorer households because they can rent their land to households with larger livestock holdings and earn income. Alternatively, households can elect the group or village to be the formal unit of tenure, provided that they decide to do this before the land is subdivided. The amount of land they would receive is based on the same per-household animal and human population calculation as for individual allotments. The county has established a use tax of 0.05 RMB/day for each Sheep Equivalency Unit (1 RMB = US\$0.12). The grazing fee will be collected by the village or group leader and redistributed among the member households within the village or group.

Household tenure and collective management

A case of household tenure but collective management is found in the farming community of Tuo Munan, in south Zhongdian County, northwest Yunnan. In 1992, the AHB allocated common winter pasture area to individual households on the basis of number per family (average 2 hectare per household) and helped the community to plant the fields with exotic pasture species ("artificial pasture"). Land was allocated to households according to a process similar to that planned for Naqu County (as outlined above). However, the farmers of Tuo Munan have taken the initiative and made the commitment to effectively manage their artificial pastures through collective arrangements, unlike many neighboring communities that also received similar government assistance. Grazing is only allowed for a specified 10-day period, after the barley is harvested, with the dual objective of providing forage for the sheep and fertilizer for the soil. The collective pasture is grazed by

the whole community during this period, after which grazing is forbidden, and there is a reversion to a household-cropping tenure regime. Through these arrangements, farmers have been able to avoid the cost of fencing individual boundaries and also reap economies of size with respect to herding labor and pasture maintenance (Figure 4).

Household tenure—group management

Maqu County is located in southwest Gansu Province and is a purely pastoral region. The county AHB, with financial assistance from OXFAM Hong Kong, has been implementing a pastoral development project since 1999. Under this project, household boundaries in winter pasture have been delineated but groups of up to 10 households in size have been allowed to pool their pastures together and fence the outer boundary. The benefits, as perceived by the pastoralists themselves, include the lowering of fencing costs and the continued realization of economies of size with respect to herd supervision, as households take turns at supplying labor for supervision of the joint herd.

The group tenure arrangement also facilitates the provision of social insurance. Reflecting the ongoing emphasis of policy on equitable distribution, the area of rangeland allocated to households remains based on their early 1980s livestock numbers. However, because household herd sizes are now considerably differentiated, there is a mismatch between the size of household herds and the rangelands allocated to them. With the Maqu County approach, the total number of stock units that can be grazed on the joint pasture and each household's share of this are calculated. Households that graze fewer livestock than the hypothetical carrying capacities of their portions of the joint pasture are compensated by those households that graze more. Poor households are thus guaranteed access to forage equivalent to that produced by their pasture if they need it and can earn supplementary income in the form of land rents to the extent that they do not need forage.

Implications for grassland policy

The field-level evidence presented here illustrates that—unlike in arable land where individual tenure and household management proved to be the only workable institutional arrangement—in the grasslands of western China, a large element of group tenure and community-based management has persisted. Such differences in tenure and managerial institutions raise 2 closely related legal issues: whether rangeland tenure should be treated differently than arable tenure in law and, if so, how. The unique natural features of rangeland as discussed above, including ecological fragility, uneven

access to water resources, remoteness from residential quarters, difficulties in demarcation, and heavy reliance on group enforcement of any policy and legal measures, make rangeland distinctive from arable land in terms of management and production. Moreover, the existence of these rangeland features is different from region to region, resulting in a much more complicated mosaic than arable land. Any legislation designed to facilitate the sustainable use of rangelands must take these factors into account.

Rangeland is classified as agricultural land under the 1998 Land Management Law. The Rural Land Contracting Law (RLCL), enacted in August 2002, includes grassland under the category of agricultural land (Article 2), which is subject to a system of “contracting and operation” (Article 3). The contract term for grassland is for 30 to 50 years (Article 20). With respect to how such “contracting and operation” should be conducted, the law states that “contracting of rural land shall adopt the form of household contracting within the collective economic organization” (Article 3) while remaining silent on the issue of “operation and management.” However, based on a careful reading of the law, one may plausibly conclude that individual tenure in the form of grassland contracting rights allocated to farmer–herder households and the joint management of such property are not mutually exclusive; rather, a collective or group management arrangement based on the joining of legally defined individual land rights, if voluntary, is legally permissible.

It is important to note, however, that the RLCL makes no distinction between arable land and nonarable land, including rangeland, in terms of initial tenure arrangements. Under the RLCL, only the household contracting approach is explicitly authorized. Although the law does not rule out other forms of grassland tenure in plain language, it is clear that the legislators favor a universal application of household contracting regardless of geographical differences and inherent distinctions between arable land and nonarable land. If alternative tenure arrangements are not explicitly accommodated in provincial implementing regulations for the national RLCL or the forthcoming revised Grassland Law, they may be perceived to be in conflict with the legal framework and thus illegitimate.

The best legal vehicle for further clarification of the application of household contracting to rangeland is the revised Grassland Law, which is currently under legislative review. The draft submitted to the Standing Committee for first reading (of 3) contains a provision that “[g]rassland that is collectively owned or state-owned but used by collective economic entities in accordance with law may be contracted to individual households or groups of households within the collec-

tive entity” (Du Q 2002). Clearly, the legislative attempt to differentiate grassland from arable land with respect to tenure arrangement better reflects the reality in rangeland tenure arrangements and certainly entertains our findings in the field.

If the final version, in conjunction with provincial implementation regulations, continues to ratify group contracting and explicitly permits joint use of rangelands contracted to households, the issues of rangeland tenure and management would be better addressed. One may have a concern over the potential conflict between “household contracting” under RLCL and “group of household contracting” supposedly in the forthcoming revised Grassland Law. It is not entirely clear whether “group of household contracting” is legally incompatible with “household contracting”; even if it were, the conflict could be easily resolved under the 2000 Legislation Law (Article 83), which provides that where there is a conflict between a special law and a general law, the special law prevails.

Provincial governments, especially those in provinces where a major part of the landmass is composed of rangeland, may also address this issue in their implementing regulations for the RLCL. Under the RLCL (Article 64), provinces, provincial-level cities, and autonomous regions are authorized to promulgate implementation regulations based on specific situations within their jurisdiction. Because RLCL does not explicitly prohibit rural land contracting by entities other than individual households, provincial governments should be able to adopt special rules on grassland tenure. At the very least, these provincial regulations should authorize local governments to adopt flexible management modes, including collective or group tenure arrangements, that they see most fit for their particular situation.

Conclusions

Given the social and ecological context of pastoralism in western China, the continuation of collective and group tenure arrangements and, more broadly, community-based management, is appropriate. Key aspects of grassland policy in the reform period that have not been consistent with this context have failed to be implemented on the ground or have not had their intended impact. Several pilot projects over the last half-decade have illustrated the wide range of potentially workable grassland tenure–management arrangements that exist. Contemporary changes to the legal and regulatory framework governing grassland tenure offer a window of opportunity for legitimizing both these arrangements and the adaptive and participatory approach to policy implementation that have underpinned their development.

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