



Why Do Herdsmen Not Support Deratization? A Survey on the Awareness of Rodent Control in the Tibetan Areas of Sichuan Province, China

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ABSTRACT

Rodents are a critical part of the grassland ecosystem, but at a high population density, they trigger grassland desertification, unsustainable development of animal husbandry, increase in the incidence of rodent-borne diseases and the potential for zoonoses. The Sichuan Tibetan area is ecologically fragile and has reported the most serious rodent damage in China. The rodent control technology is presently advanced and diverse, however, awareness among the herdsmen in this area to control the rodents remains relatively regressive. Given the limitations in organizing herdsmen to participate in the government-organized rodent control, open-ended and closed-ended combined questionnaires were executed in the summer of 2020 for investigating the consciousness of deratization and the factors influencing the herdsmen. The age of the respondents ranged between 18 and 73, and 261 valid questionnaires were collected. The results demonstrated that the herdsmen who agreed with deratization were between 31–40 years old (71.70%), possessed a college education or above (69.92%), killed rodents when their damage was serious (70.48%), and participated at least once in deratization organized by the government (76.35%). There was a significant difference in the awareness of rodent control among the herdsmen having different education levels. The consciousness for deratization among the herdsmen was affected by age, education level, attitude towards killing rodents, and several other factors. Thus, it could be concluded that improving the levels of education, the prevention, and control mechanisms, as well as reshaping the deratization concept can encourage the herdsmen to establish a scientific and rational ecological explanation justifying the necessity of deratization. This can not only contribute to the long-term prevention of disease and damage caused by the rodents in the Sichuan Tibetan area but also benefit the local sustainable development.

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Key words

Awareness of deratization, Sichuan Tibetan area, Age, Education levels

INTRODUCTION

Rodents constitute an important component of the grassland ecosystem. They not only serve as the main food source for the raptors and carnivores (Aho *et al.*, 1998), but also carry seeds during storage, which is conducive for spreading the plant species in the area. Moreover, their abandoned tunnels can serve as a shelter for other small animals (Zhang and Wang, 2001; Cheng and Zhang, 2005). However, when an imbalance is set in an ecosystem, it triggers the rapid growth of the rodent population density. This results in the loss of the soil

nutrient, changes in the plant community, decline in the grassland quality, and an increase in the risk of rodent-borne diseases (Huang *et al.*, 2009; Liu *et al.*, 2003, 2020; Jiang *et al.*, 2004). In extreme cases, there is an increased prevalence of the black soil beach, along with extremely low vegetation coverage (Zhou, 2006). Therefore, to ensure a balanced and functional ecosystem, it is necessary to organize and plan the prevention and control of rodents in the areas prone to severe rodent damages.

The complex and diverse ecological environment of Sichuan Province provides suitable habitats for rodents. There are 101 species and 105 subspecies of rodents distributed in the territory, belonging to 2 orders, 12 families and 41 genera (Li *et al.*, 2018). The Tibetan grasslands in Sichuan are one of the areas with the most severe rodent infestation in China. The average rodent-infested area is 2.92 million hm², of which the severely damaged area is about 1.87 million hm² and the desertification area is about 53,000 hm² (Zhao *et al.*, 2015). In Tibetan areas of Sichuan, rodents are widely distributed in Garzê and Ngawa prefectures, and counties such as Shiqu County, Ruorgai County, Ganzi County, and Hongyuan County

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have a high proportion of damage (Fig. 1). The main ‘pest’ species are the plateau pika (*Ochotona curzoniae*) and the plateau zokor (*Myospalax baileyi*), both of which have strong reproductive and adaptive capabilities, and their numbers can increase dramatically in a short period of time, consuming a large number of high-quality forages, reducing the livestock carrying capacity of these grasslands. It exacerbates the degradation, desertification and soil erosion of grassland, affecting the protection and construction of grassland ecological environment, social stability in ethnic areas and the healthy development of grassland animal husbandry. And probably leading to outbreaks of zoonotic diseases, such as plague and echinococcosis, incurring serious health risks, ecological and economic losses (Liu *et al.*, 2020). Therefore, maintaining a balanced ecosystem in the Tibetan areas of Sichuan is not only important locally, and provincially, but also of significant interest to China on the whole.

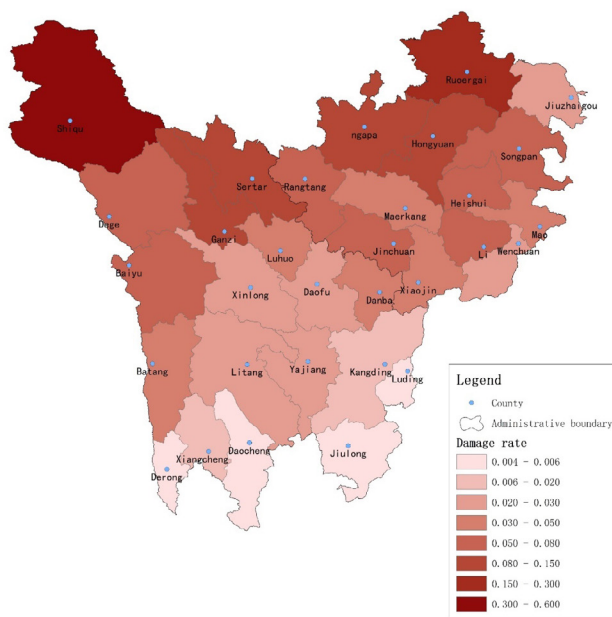


Fig. 1. Distribution map of plateau rodent infestation in different counties in Tibetan areas of Sichuan.

At present, the technologies for preventing and controlling damage caused by rodents are well developed, and include rewilding of foxes, enclosing grasslands, and rotating domestic grazing. However, the effective implementation of these techniques demands a good prevention and control mechanism. To date, China has gradually devised a mechanism of overall planning, unified defense, and governance, state support, which involve the active participation of farmers and herdsmen. However, in the pastoral grassland areas, especially Tibetan ones,

the farmers and herdsmen are not very active participants which make it difficult to organize mechanisms for artificial prevention and control (Hong *et al.*, 2014). According to the doctrines of the Tibetan Buddhists, all life is equal, killing is a crime, and monks and lakes should abide by the basic guidelines of non-killing. In Qinghai, the religious beliefs of “no killing” have led to low to no rodent control. Settlements and livestock pens can become refuges with a rapid rebound of rodent damage (Han and Tang, 2019). To promote the active participation of farmers and herdsmen, methods like signing agreements on preventing and controlling rodents should be adopted (Liu *et al.*, 2017; Ying, 2018). Based on these reports, our study has investigated the rodent prevention and control awareness of the herdsmen in Sichuan Tibetan areas, by analyzing its influencing factors and providing a theoretical reference for formulating a mechanism of rodent prevention and control in line with the local conditions.

MATERIALS AND METHODS

The Tibetan region of the Sichuan Province, located in the pastoral farming ecotone of the southwest mountainous region has an area of 2.5×10^7 hm². It is one of eight ecologically fragile regions in China. With a total population of more than 2 million, of which 64% are Tibetans, this area is also the second-largest Tibetan area in China. Tibetans are believers of Tibetan Buddhism, and most of their income comes from animal husbandry. The grasslands in the Tibetan areas of Sichuan have concomitantly become one of the most extreme rodents-infested areas in China.

In the summer of 2020, herdsmen from the Tibetan area of Sichuan were randomly selected as the survey subjects and household surveys were conducted using open-ended and closed-ended combined questionnaires. Since most of the herdsmen had a low level of education, they often faced difficulties communicating in Chinese during the survey. The Tibetan college students were responsible for translating and interpreting the questionnaires to the herdsmen. The age groups of the respondents were divided into ≤ 20 years old, 21–30 years old, 31–40 years old, ≥ 41 years old. The level of education was divided into 4 categories: elementary school and below, junior high school, high school (including vocational high school, technical secondary school, technical school), college degree and above. The survey mainly collected the basic information of the herdsmen based on the awareness of rodent prevention and control. Using ArcMap 10.2 software to make the distribution map of rodent damage in Tibetan areas. The data were analyzed using the SPSS 22.0 software, and the data on rodent prevention and

control consciousness among the groups of different ages, different education levels, and different control awareness were analyzed using the Pearson's chi-square test. This survey was composed of a total of 300 questionnaires, of which 261 were used in the analysis. The age of the respondents ranged from 18 to 73 years old. The success rate of the survey was 87%.

RESULTS

Effect of the herdsmen's age on the support for deratization

In this study, a total of 261 questionnaires were collected among which 104 were under 20 years old, 54 were between 21 and 30 years old, 53 were between 31 and 40 years old and 50 were over 40 years old. No statistically significant difference was found in the deratization attitudes (support, not support, or do not care) among the different age groups (Chi-square, $\chi^2 = 7.368$, $P = 0.288$) (Fig. 2).

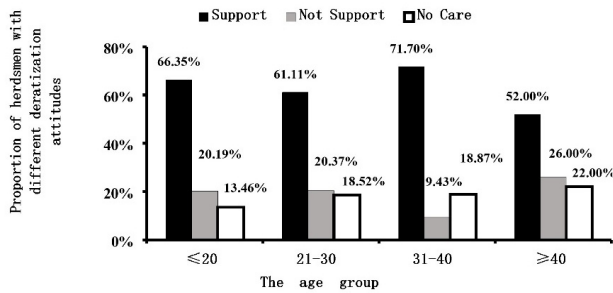


Fig. 2. Effect of herdsmen's age on the support of deratization.

Effect of education levels of the herdsmen on the support for deratization

When the effect of education levels of the herdsmen was assessed, significant differences were observed in the rodent control attitudes among the groups with different education levels (Chi-square, $\chi^2 = 20.031$, $P = 0.003$) (Fig. 3). The proportion of people who approved deratization was biased towards individuals who were more highly educated, while the proportion of people who opposed it was from a lower educational background. The group with a college education or above showed the highest proportion of approval towards deratization, but the group with a junior high school education or less showed the highest proportion of opposition (Fig. 3).

The composition of educational level among the herdsmen of different ages

Since economic development, the popularization of education, and other background factors might affect

the education level of herdsmen, the composition of the education level of herdsmen of the different age groups was investigated. The survey results indicated a trend that the younger the herdsmen, the higher were their education level. Among the herdsmen above 20 years old, most of them were found to have a high school education, and the proportion of them with a college education or above was found to increase significantly (Fig. 4).

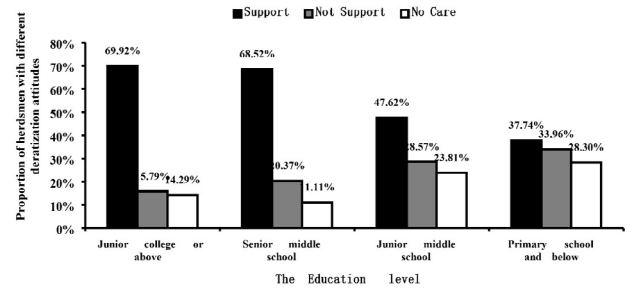


Fig. 3. The consciousness towards deratization among the herdsmen with different education levels.

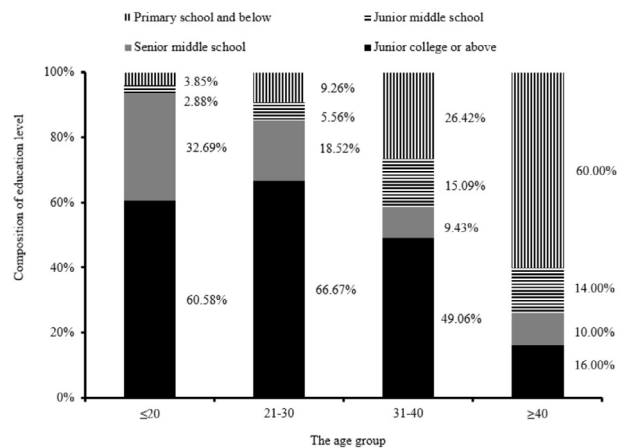


Fig. 4. The composition of educational level among the herdsmen of different ages.

Consciousness for killing among the herdsmen with different deratization attitudes

Among the herdsmen who agreed with deratization, most of them thought that rodents can be killed when their infestation would affect their daily life, such as stealing food, eating forage grass, and so on. Moreover, only a low percentage opined that these rodents should not be killed at all (Fig. 5). Among the herdsmen who opposed deratization, there was a higher proportion of herdsmen who believed that the animals should not be killed at all. At the same time, the proportion of herdsmen who believed that rodents can be killed when the damage by

the rodents affected their daily life, reached close to 1/3 of the not support group (Fig. 5).

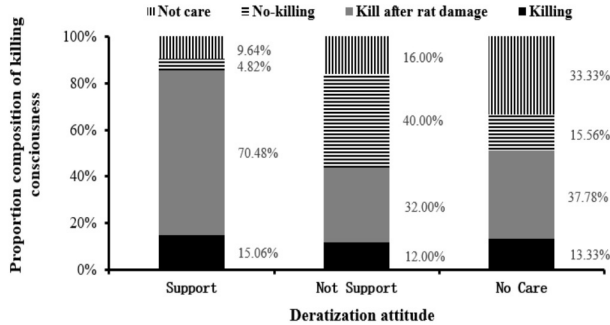


Fig. 5. Consciousness for killing among the herdsman with different deratization attitude.

Consciousness for killing among the herdsman with different education levels

As shown in Figure 6, among the herdsman with high school, college, and above, the proportion of herdsman with a consciousness of kill after the rats cause damage was found to be higher than that of the junior high school and elementary school. Among the herdsman with elementary education, the proportion of herdsman holding the consciousness of no killing was found to be higher than the other groups (Fig. 6).

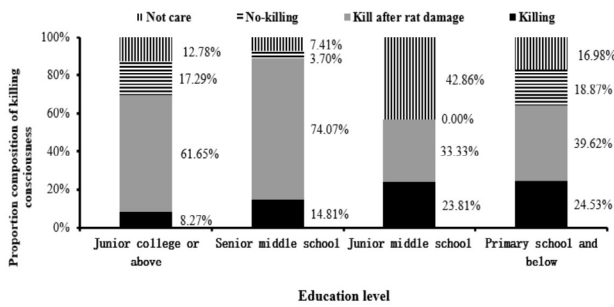


Fig. 6. Consciousness for killing among the herdsman with different education levels.

The impact of the government's anti-rodent work on the herdsman's awareness for deratization

The participation of herdsman in the government-organized anti-rodent work was found to decrease the percentage of herdsman who did not approve of deratization. Among the herdsman who participated in the government's deratization work, the majority of them agreed with deratization, which was higher than the herdsman who did not participate in it (Table I).

Table I. Influence of the participation of the herdsman in deratization organized by the government on their deratization awareness work.

Herdsman's attitude of deratization	Have herdsman participated in the deratization organized by the government?		
	Participated	Never participated	Unclear
Support	113(76.35%)	52(46.85%)	1
Not support	20(13.51%)	30(27.03%)	0
No care	15(10.13%)	29(26.13%)	1

DISCUSSION

Activities like digging and feeding of rodents disturb the soil structure, acting as the main cause of grassland degradation (Liu *et al.*, 2020). Generally speaking, in ecosystems with changeable climate, relatively single vegetation, and simple species structure, rodent populations are prone to sudden increase and cause harm (Yao *et al.*, 2005). Rodents are not only primary consumers, but also important food resources for carnivores, and are very important to maintain the stability of grassland ecosystems. However, due to the degradation of grasslands by human overgrazing, herbivorous rodents frequently dig to obtain food, which exacerbates the degradation and desertification of grasslands. Taking the diet of the plateau zokor (*Myospalax baileyi*), one of the most serious rodents, as an example, the plateau zokor mainly eats weeds. The rodent population increased rapidly, and the increase in rodent density further exacerbated the degradation of pasture, entering a vicious circle (Wang *et al.*, 2000). Rodent infestation has a serious impact on the production and life of herdsman. For example, the degeneration of grassland caused by rodent damage cannot provide sufficient pasture for cattle and sheep, which affects the stocking capacity and inhibits the development of productivity. Now grassland rodent damage has become an important threat to the development of grassland animal husbandry. The desertification of grasslands will also lead to soil erosion and ground subsidence, which not only destroys the ecological environment, but also seriously threatens the personal safety of herdsman. a large number of bacterial infectious diseases carried by rodents also endanger the health of herdsman and livestock.

The presently available technical methods of rodent control mainly include physical, chemical, and biological methods. Physical methods mostly comprise squirrel cages, rat traps, bows, and arrows while the chemical methods include anticoagulants, birth control agents. The biological methods comprise biological toxins, natural predators and are widely used since they are considered

environmentally friendly with no secondary negative effects on the livestock. Given sufficient technical means to eliminate rodents, the efficacy of deratization depends not only on the applicability of the technology itself but also on the willingness of residents to cooperate in their implementation. Therefore, the awareness among the residents about the necessity for eliminating the rodents ensure successful deratization (Hong *et al.*, 2014). The Tibetan plateau of Sichuan has large sparsely populated areas, where rodent damage can be widespread. These areas are difficult to tread and lack sufficient manpower. Therefore, convincing residents of the importance of controlling these rodents and having them actively participate, are prerequisites for effective rodent control.

As per our study, age is an important factor influencing ecological and environmental awareness among the residents. The research on urban residents showed that, as people grow older, not only do their life experiences increase, but they also pay more attention to their health. At the same time, their awareness of the ecological and environmental impacts strengthens with age (Liu *et al.*, 2018). In contrast, our study found that the proportion of herdsmen who were in favor of deratization, decreased with age, particularly among those over 40 years old. The reasons for this trend could be the slow economic development and low overall education levels and these have only started to improve in the past 20 years. The residents above 40 years lacked educational resources during their school-age and failed to receive adequate education in modern scientific knowledge. Second, the traditional sources of information via media (such as newspapers, books, TV, or radio broadcasts) are gradually declining, while the new media (social networks, texting, and other forms of communication) have increased rapidly, changing the means of knowledge transmission. Residents above 40 years have relatively weak acceptance for the new media and show their disability in acquiring relevant knowledge which restricts them from forming a scientific awareness of the importance of deratization, similar to the ecological awareness of the farmers to the problem in the Jiangsu Province (Dai, 2018). Third, for the poorly educated people, the most important or even the only source of knowledge is the Tibetan Buddhist temples. Most of the residents in the Tibetan area of Sichuan are believers of Tibetan Buddhism. In Tibetan Buddhism, the profound principles which preach that all beings are created equally, and preach about karma, the circle of life, and six realms of Samsara, which tend to affect the believers for generations, resulting in a series of customs, such as ahimsa, protection, release, worship, sacred mountain and lake, and celestial burial. These customs have evolved into the social and ethical norms of

the Tibetan people (Liu, 2007; Wen, 2017). These beliefs and behaviors have prompted the Tibetan people to take the initiative to protect the lakes, mountains, and wild animals and plants in their living environment, with great and far-fetched significance in ecologically protecting the Tibetan areas (Wang, 2013). However, these ideas result in protecting all living things, without distinction, and lack scientific rational analyses, which often lead to some ecological and environmental problems. For example, in the pastoral areas, no rodent control measures are taken even if the rodents severely damage the grasslands (Yang and Shang, 1994). Introducing non-native species during the release process causes biological invasion, for example, the release of farmed carp into the plateau water system has adversely affected the original cold-water fish (Liu *et al.*, 2017). The families of the herdsmen have cattle and sheep, but their lives are difficult due to the extremely low rate of slaughter (Ma, 2010). There are two reasons why herdsmen aged 31 to 40 have the highest percentages of approval for deratization. On the one hand, due to the relatively slow economic development in Tibetan areas, compared with herdsmen over the age of 40, herdsmen aged 31 to 40 are in the development stage of the country after the reform and opening up, and have received a certain basic education, so the percentage of herdsmen in favor of deratization is higher than that of herdsmen over the age of 40. On the other hand, although their education level is lower than that of herdsmen under the age of 30, because the herdsmen in this age group are basically the main force of pastoral grazing, compared with most herdsmen under the age of 30 who work and go to school, they have frequent exposure to rodents and have a deeper sense of the effects of rodent infestation. Therefore, the herdsmen aged 31 to 40 have the highest percentage of agreeing to deratization (Fig. 2).

The higher the level of education, the more are they aware of the environment, with corresponding changes in their attitudes and behaviors. Moreover, they tend to do the right things for the environment. Therefore, education is an important factor affecting environmental awareness and behavior (Su *et al.*, 2020; Barliana *et al.*, 2016; Bozoglu *et al.*, 2016). In recent years, rodent damages have worsened in the Sichuan Tibetan areas. For example, in Hongyuan County, Aba Prefecture, the plateau zokor density is as high as 40.92 per hectare, and the level of damage is serious (Deng *et al.*, 2017). This has led to a decline in the proportion of high-quality forage grass, with an increase in the proportion of weeds (Liu *et al.*, 2020). Damages by rodents have evolved as an environmental problem in the local area that cannot be ignored. The results of this study showed that education level can significantly affect deratization attitudes, and suggested that scientific

knowledge can effectively enhance the understanding of the people about the importance of rodent control and how it is associated with the environment and their livelihoods.

Similarly, education might also directly affect the awareness of killing. Most herdsman with high school and university education tend to agree that they need to kill the rodents when their infestation worsens and this proportion is significantly higher in the herdsman with high school and university education than that of herdsman with junior high school and elementary school education.

The implementation success of environmental policies has been closely related to the public's environmental awareness. People's environmental awareness is mainly reflected in thinking about the relationship between the people and the environment, which is affected by the factors such as religion, education, gender, income, and culture (Su *et al.*, 2020; Wu *et al.*, 2020; Gifford and Nilsson, 2014). Public awareness has improved with comprehensive rodent control work. Despite the Tibetan Buddhism beliefs, and the tendency to worship nature by Tibetan herdsman (Wu *et al.*, 2020), more and more people have depicted an increasingly rational attitude towards controlling rodents with the development of education and economy. Not surprisingly, a high proportion (32–70.48%) of herdsman thus believed that rodents should be killed when the damage inflicted by them worsens. The ultimate goal of rodent control is not to kill all the rodents, but to control the density of the rodent population within a reasonable range, maintaining the ecological functions of rodents, and ensuring no environmental damage. On the other hand, the organized large-scale rodent eradication work by the relevant government agencies would positively impact the local herdsman, improving the habitat, and thus significantly increasing the proportion of local herdsman who approve of rodent eradication.

The comprehensive rodent prevention and control work in the Tibetan areas of Sichuan has its challenges. Our study highlights the various factors that need to be considered comprehensively in the rodent control project and measures in line with the local conditions that should be formulated to effectively control the rodents in the long term. Therefore, the following recommendations can be drawn.

Improving the overall level of education and encouraging higher education while emphasizing environmental education in elementary and middle school. Studies have shown that pure Chinese teaching can significantly reduce the religious identity of the Tibetan middle school students, and active participation in the Communist Youth League activities can promote the students to evaluate scientifically, wisely, with a correct view and behavior that would abide by their religion (Zhang, 2014). The content of the education emphasizes

combining theory and practice, closely connecting with local environmental issues, and promoting scientific knowledge closely related to the production and life of the masses, conducive to the correct understanding of the contemporary value of Tibetan Buddhism and the formation of scientific and rational awareness about deratization (Wen, 2017).

Formulating relevant policies at the institutional level, strengthening the comprehensive prevention and control of rodent pests, establishing a complete and operationally feasible rodent pest prevention and control system. At the same time, more attention should be paid to the publicity of government work and encouraging the local herdsman to actively participate in it to expand their influence among the local herdsman. These methods can help in reaching scientific and rational awareness about the transformation of their rodent control.

Reshaping the idea of sustainable development from the conceptual level, and assisting the local herdsman to establish a scientific and reasonable awareness on controlling the rodents that conform to the laws of the ecosystem. On the one hand, publicity can be increased, by circulating relevant environmental knowledge through multiple channels and making full use of new online media. On the other hand, in the propaganda process, a targeted approach to the different ages and different levels of education can do more with less.

CONCLUSIONS

The results of this study show that the herdsman's awareness of deratization is different due to factors such as age, education level, and Tibetan customs. In Tibetan areas of Sichuan, by improving the education level of local herdsman, the government regularly can organize the large-scale rodent eradication work and publicity and other means, and is beneficial for promoting the herdsman to develop a scientific and reasonable awareness about preventing and controlling rodents with a positive impact.

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Statement of conflicts of interest

The authors have declared no conflict of interest.

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