A smart model of the rural village planning

P Wu1 and Y Lin2

1Faculty of Graduate Institute of Landscape Architecture, Tung Hai University, Taichung, Taiwan
2Director of Wumo Architects, Taichung, Taiwan

E-mail: 879579@gmail.com

Abstract. The smart model of rural village planning is to build a digital platform to connect agriculture and industry through big data. The process starts with the construction of a big data agricultural platform, then planning and designing the physical environment of the smart village, and the third stage is the creation of a multi-industry alliance and co-operation model. For combining agricultural demand and physical access information data, the cloud database can obtain the required information and achieve the exact goal of increasing agricultural income. In addition, agricultural tourism uses the urban planning concept to carry out village layout, and develops qualitative and quantitative regulations, ecology, landscape and tourism data in scientific calculations to control the intensity of land use that can be supported by rural areas and provide the best tourism condition and ecological environment. The project also builds a shared economic model in which enterprises contribute to assisting farmers in housing repairs and invite them to participate in operations. Thus, farmers are transformed into inheritors and educators, and they are able to participate in the operation of the village as a teacher, so that the culture of sustainable agriculture can continue.

1. Introduction

In the past history of human development, the industrial revolution has been a great leap forward in the development of human civilization, and the pace of urbanization has been accelerating and expanding. Marvin and Luque [1] pointed out that the over-expansion of population caused by urbanization, rural poverty, environmental pollution, inadequate public construction, health diseases and other issues have worsened, and urban living environment and other related issues have gradually emerged. With the rapid growth of economy, mainland China has flourished for more than 30 years since the reformed and opened up and has leapt to the core of the world economic stage. However, the hidden worry behind the huge gap between urban and rural areas has become one of the key issues that must be faced at the same time [2]. The phenomenon of domestic immigrants from urban migrant workers and rural populations to urban areas has also continued to reduce the number of rural residents [3]. In contrast to the booming development of cities and towns, rural residents have left their homes to invest in the convenience of the city in order to pursue higher economic income and self-realization [4]. The loss of rural population, slow rural growth, and local cultural faults have become the biggest worry for rural progress, so the State Council of China issued a national poverty alleviation and development work.

In the modern rural areas, due to the lack of life inheritance in the outflow of the population, the issue of how to make the farmers getting the real benefits and fair distribution on the crops, so that the
farmers can surpass the urban migrant workers and even the general blue-collar class income, and attract the rural areas of the living cities is crucial. The account is refloowed, and then the layout and connection of the third industries of commerce, tourism and the secondary industries are carried out by means of sustainable management. It is hoped that this concept can achieve a balance point between development and environment, economy and ecology. Also, it has a friendly space for coexistence in rural construction and tourism development. Under the concept of complete land development model, the developed land products will be given new definitions, and the rich ecological content of the products will form a segmentation from the original market; with appropriate planning and design, the unnecessary land development process will be reduced [5]. Through effectively reducing development costs in the entire development process, a large number of cutback to the natural environment, ecological damage, shaping the attitude and responsibility of the company's environmental responsibility, and the corporate image has a significant improvement which gives feed-back to the company's innovative product value. For rural development is not just a question of farming and housing, cross-domain integration of related industries has become an inevitable result.

The empirical site of this study is Yanzi Village, Dawo Town, Gao County, Yibin City, southeast of Si-chuan Province of China, which is an agricultural county dominated by mountainous hilly terrain. Dawo Town Rural Complex Industrial Park project covers an area of about 27 hectares and contains general farmland, house site, woodland, reservoir, and road agricultural facilities. Land use category belongs to agricultural land and is a typical rural community at present and the total number of farmland households in the site is 12.35 hectares. However, there are no public facilities on the site and the gathering activities of the public are concentrated in the upper town hall of Dawo Town. The agricultural farming is carried out in full accordance with the natural season cycle [6]. One of the neighboring village is the existing tourist attraction in the town. Its cabin accommodation environment built by lake has the most beautiful scenery of the lakeshore, the life style of the agriculture in the mountains can attract some people who desire to escape from the city to rest. The circumstance is hard to compare with the complete tourism supporting industry and rural participation activities. Thus, the government is actively promoting the rural complex to raise rural tourism and recreation opportunities.

Therefore, the main objective of this study for Dawo Town Rural Complex is to improve the local crop market value on the premise of maintaining the current environment ecology and rejuvenation, including the sustainable development of agricultural management, commercial market operation, network platform, sight-seeing tourism, environmental education and cultural preservation. Establishing the sustainable countryside with recycling ecology to create wealthy villages and become a comprehensive agricultural platform for surrounding villages. Agricultural upgrading aims to introduce advanced farming technology, promote agricultural industry, build promotion hub, technology platform and supply of materials, and use this technology to drive management, technical, R&D, business planning talents to build incubators, agricultural talent bases and brands. Secondly, acquiring the optimization of land use division, and the future utilization of the land can also be operated under the most reasonable conditions. Finally, set up counselling mechanism, marketing promotion, education cooperation, job creation, modern business model and online big data operation to establish brand characteristics, integrate rural complexes, upgrade traditional rural areas into a miniature modernity place with agro-ecological value.

2. Method and material
The establishment of a sustainable agricultural integrated platform of products, tourism, education and cultural preservation for rural areas through the use of ubiquitous network technology and the Internet of Things (IoT) is necessary. The important technology such as RFID electronic tags, Artificial Intelligent (AI), 5G, provide technology which integrates users to manage big data analytics to achieve the most appropriate development and cost-effectiveness of the best management [7]. Thus, the smart model of rural village planning is a comprehensive development plan constructed with agriculture as the original structure. Combine agricultural big data in the scope of the base plan with the Internet of Things, cloud computing, and central management technology, master the production, logistics, and
sales core of agricultural products, and then enhance the real income of agricultural production, and at the same time construct a rural area with smart agriculture, smart environment, and smart tourism [8]. The process for smart rural construction, each with its corresponding steps and priorities is as follows.

2.1. Agricultural value chain construction

Value chain, also known as value chain analysis, value chain model, etc. was proposed in 1985 by Michael Porter in the book Competitive Advantage [9]. Porter pointed out that companies must develop unique competitive advantages and create higher added value for their goods and services. The business strategy is the business model of the structural enterprise, and it becomes a series of value-added processes. The series of value chain of a general enterprise is mainly divided into primary activities and support activities. First, primary activities include the core production and sales program of the company: (1) Inbound logistics that is incoming materials storage and transportation belongs to the resource market. (2) Operations which is processing and manufacturing belongs to a manufacturer's market. (3) Outbound Logistics that is finished product storage and transportation belongs to a middleman market. (4) Marketing and sales belongs to the consumer market and (5) after sales service is also included. Secondly, support activities, including other activities that support core operational activities, are also known as joint operations [10].

With the development of the Internet technology and logistics industry, farmers have opened up new paths on the Internet. They operate communities and websites, join local organizations, and sell their own agricultural products directly on the Internet. From the place of origin to the consumer, there is no need to stack the price at the layer level, only the logistics cost. The advantage is that the price can be higher than the old process when the traditional large supply of wholesalers, but the price to the consumer is not more expensive than the outside. The shortcoming is that farmers must be responsible for the operating costs of goods and reduce the labor intensity. However, farmers in the study site have not used this sales model.

Therefore, setting up a statistics platform of big data, including digital management cores such as production data, market demand, price analysis, channel transportation and webpage sales platform, integrate the data required for production from production to sale, and carry out scientific assessment planning [11]. Timing to increase market acceptance and selling prices at crop harvests to avoid saturation of oversupply. The production and sales resume can be improved through the open sales platform and big data logistics to enhance the trustworthiness of agricultural products and the image of agricultural products. The market supply and product prices can stabilize the market stability of supply and demand.

2.1.1. Agriculture. Cloud big data provides production control, exquisite agriculture, mechanizing agriculture, organic farming method, coaching brand and production and sales resume certification to complete industrial upgrading.

2.1.2. Logistics. Cloud big data provides production control, exquisite agriculture, mechanizing agriculture, organic farming method, coaching brand and production and sales resume certification to complete industrial upgrading. Master the demand and supply market, combine with the analysis of the cloud market, the improved agricultural products will be exported in a friendly platform to reduce the transaction links, and the intermediate profits will be returned to the rural and rural households.

2.1.3. Cultural Innovation. After the promotion of the agricultural industry, it also grafted cultural, commercial, management and other employment opportunities, providing rural youth cultural and commercial space to prevent rural outflows.

2.2. Agricultural value chain construction

Stage two is the development of smart environment model. Based on the concept of small-scale urban planning, and the statistical analysis of the land-supportable strength, the layout of the site conditions, and the use of the time axis to estimate the past, present and future estimates of the maximum land use intensity. Control construction management configures various use zones such as homestay, commercial, public, road, industrial processing, sightseeing and tourism supporting land. Then, limit
the scope of agricultural production and future tourism industry which will impact on the environment in advance, and maintain the agricultural living environment and surrounding ecologically [12]. Thus, land use management can effectively improve the control of the impact of rural and various tourism, processing, and cultural industry activities [13]. In line with big data monitoring and data acquisition, the central management core analysis can control the environmental changes in the site, which can be used as academic research materials and instantly adjust agricultural farming and tourism development models.

2.2.1. Land. Refer to the concept of urban planning, plan the rural environment to reach the upper limit of living, production, and ecological balance, and then carry out micro-urban planning to ensure the sustainable development of rural land.

2.2.2. Environment. Controlled development activities provide more ecological research data, including natural resources such as water resources utilization, wind power, forestry, etc., which can also achieve the advantages of environmental conservation and symbiosis and mutual benefit within the control scope.

2.2.3. Ecology. There are planned and controlled development activities that provide more development space for natural ecology, and indirectly provide potential and objective value for academic research, environmental parameters, tourist attractions, and better quality of life.

2.2.4. Real estate. Under the conditions of micro-city planning and environmental and ecological control, we plan to designate residential, commercial, industrial, cultural, educational, and hotel-related land to attract enterprises to invest in real estate development and provide space for living and activities needed for reversing urban immigration.

2.3. Smart management strategy
After the first stage of the smart agricultural structure to improve farmers' income, and the second stage into the overall development plan and management of the smart environment, the farmers have the economic autonomy and environmental control plan, and then carry out the third stage of smart tourism to set up rural tourism promotion. The third stage is based on the foundation of farmers' stable income and environmental and ecological sustainability. The number of tourists and the intensity of land support calculated from the big data can avoid the speculative atmosphere brought about by rural tourism or the inappropriate use of fallow, occupation, diversion, etc., fully comply with the better farmland control policies and regulations. At this time, the operating right can be returned to the village organization, the government unit or the civil construction unit that originally constructed the smart village planning model to continue operation and management.

2.3.1. Leisure and tourism. When the rural areas have reached the objective conditions of natural environment, sustainable ecology, local cultural characteristics, rural health, and etc., works can continue such as the integration of rural resources for smart tourism brand construction, controlling the number of tourists to ensure the overall tourism quality, but also provide rural residents income distribution and living environment construction funding sources [14].

Property management. Site development intensity management, environmental ecological monitoring management, rural environmental management, tourism mobile management, commercial logistics management, domestic waste and resource management are integrated into the smart village management core.

3. Result
Before the construction of the smart village, qualitative and quantitative planning of the base conditions and the site's support intensity must be carried out to determine the best operation mode and the most appropriate management mechanism [15]. According to different geographical conditions and background conditions, the planning intensity that is most suitable for the land is calculated and selected. In principle, the base development is carried out in a low-impact mode and the selected amount is the estimated load. Zoning needs to be coordinated with landscape environment analysis to avoid ecologically sensitive areas and geological sensitive areas for zoning and path planning.
3.1. Agricultural big data platform
Combine agricultural big data in the scope of the base plan with the Internet of Things, cloud computing, and central management technology, master the production, logistics, and sales core of agricultural products, and then enhance the real income of agricultural production, and at the same time construct a rural area with smart village, smart tourism, and smart environment. Moreover, according to the effective management model of the value chain, it consists of a series of business processes, each of which can be broken down into specific operations. Those activities involve personnel, finance, planning, research and development, procurement, etc. In the value activities of different enterprises, not every link creates value. In fact, only certain specific value activities truly create value. These truly value-creating business activities are the strategic links in the value chain.

If the agricultural products can complete the value chain operation by themselves, there is a way to establish the brand advantage. After the brand advantage is established, the transaction process and the transaction case of the goods can enter the database of effective control. Through the access and analysis of the database to provide the actual demand of the market and adjust the content of the goods, to control the product model to improve product yield and profit margin. Now the input field of raw materials brought into the value chain is used as the denominator of all values. The market value is increased according to its cost ratio. Each additional procedure in the value chain must increase the value once, but the market price of agricultural products is a fixed value. In the traditional market layer reselling, and then the market price to push back the cost of crops, the natural farmers' distribution is extremely limited; if the market value remains unchanged, it is inevitable to improve the income of farmers by reducing the channel program and increasing the value of raw materials.

3.2. Rural village planning and design
After the completion of the overall blueprint, the operations will be carried out step by step. In principle, site development is conducted in the concept of low-impact development. Regional division needs to cooperate with landscape environment analysis to avoid ecological sensitive interval and geological sensitive interval for zoning and path planning.

![Figure 1. Site Analysis](image-url)
Rural modernization, rural enterprise, rural complex, characteristic towns and other rural constructions need to deal with the problem of land use intensity. According to the Land Administration Law of the People's Republic of China, rural land is used only as a residential land or public welfare facility. The basic farmland is also subject to the total amount control and cannot be arbitrarily changed. Therefore, any rural or any land planning plan must first produce a development assessment or master plan. If the overall plan considers an open community environment rather than an internal space allocation, there must be a planning principle that can be shared by any development model. To develop a comprehensive consideration and future forecast, this plan attempts to introduce the urban planning concept and use the scientific data for land evaluation and distribution to provide the required land use intensity and location allocation for future operation and management.

The site is located between the hills of Sichuan, stretching terraces and non-commercially simple rural villages. It has a wide view to the heights, and the distant mountains set off a tranquil pastoral landscape. Compared with other magnificent scenery throughout the country, the site is more elegant and peaceful. The environmental resources include the inner landscape resources in the site and the surrounding tourist attractions. The elements of the environmental resources include the topographic and geomorphological background, the geological soil environment, the climatic resources, the hydrological environment and the river system, the flora and fauna ecology, and the current landscape (see Figure 1).

According to the legal per capita living area and cultivated land area, the maximum number of people in the planned area can be estimated, and the land use ratio of the urban planning should be set according to the population value. After calculation, the optimal construction area of the site is 3.833 hectares, the legal resident population is 1278 people, the largest tourist number is 1.517 people which is 1.5 times the resident population, and the permanent population is 391 people accounted for 30.6%. The number of farmers supporting arable land is 267, accounting for 20.9%, the number of resident population including commercial and public services is 109, accounting for 9%, and when facing the largest number of tourists, the number of commuting services is 54, with the largest distribution of 27 hectares in the region. In terms of number of people, the per capita tourist area is 141 square meters. This study uses the zoning and low-impact development mode to avoid developing land with forest and slope greater than 30%, use general farmland as the basis for changing the use of zoning to reduce development behaviour and development costs, and integrate existing roads and general facilities into each zoning. The land use zoning is as Table 1.

| Item of Land use | Area   | Unit     | Remark                                  |
|-----------------|--------|----------|-----------------------------------------|
| Forest          | 10.95  | Hectare  |                                         |
| Water           | 0.72   | Hectare  |                                         |
| Farm            | 11.01  | Hectare  | Including roads and other facilities    |
| Housing         | 3.36   | Hectare  |                                         |
| Road and others | 0.96   | Hectare  | Including parking lots                  |
| Total           | 27     | Hectare  |                                         |

The planned area of the first phase of the Dawo Town Rural Complex Industrial Park is 27 hectares. The service facilities in each district are integrated with field management and various service facilities and are connected as a part of big data intelligent management system. The site will have a very rich landscape change during the walk on the hilly terrain. The moving path cooperates with the topography and zoning management to present different rural scenery. The planning walkway is started by the flower entry plaza. After passing through the plaza, the low-shrub and fruit trees are planted to company with the beautiful scenery. Then the smooth moving path is connected to the field observation area, and then the site is entered. The southern end begins with an uphill section of the mountainous area. You can visit the flower valley, the terraced wetland and the coffee forest. This area is planted on the mountain surface for the four seasons of flowering shrubs and fruit trees, and the
back mountain surface is a vegetable grass flower plant, allowing the greatest interaction between air and the pacers, and the path moves slowly to the top of the mountain in a roundabout way with four stop areas to increase the chance of rest on the uphill section to reduce fatigue.

The division of management zones is mainly based on the existing residents' number, terrain conditions, and area of cultivated land. The rule is to define the boundaries according to the current cultivated land and the location and change of terrain as the operating principle.

Walking to the highest point of the complex park is the newly built homestay in this area. It is also the newly built town street in this district. The neighbourhood provides shopping, cultural creation, education, experience, accommodation, food and beverage snacks. The biggest feature in the activity area is the exquisite crops and seedlings planted in the greenhouse. In addition, you can go up for the ecological forestry trail. And a special restaurant for dining with afternoon tea or large events is designed there. In addition to basic diet, trading, and sanitary equipment, they are displayed in 21 areas. Other special marking items including ecological observation, explanation service, and signage stop are specifically marked (Figure 2).

When the rural areas have the objective conditions of natural environment, sustainable ecology, local cultural characteristics, health enhancement and slow life style, the integration of rural resources for the creation of smart tourism brands, to control the number of tourists to ensure the overall tourism quality, and also provide income sources for rural residents and the source of funds for residential environment construction. In addition, site development intensity management, environmental ecological monitoring management, rural environmental management, tourism line management,
commercial logistics management, living waste and resource management are integrated into a smart village management system.

3.3. Sustainable management
In the middle of the operation, smart village started to promote the tourism and experience project. In the early stage of agricultural upgrading, the agricultural materials management room constructed in each district is the preparatory space for this service. The material management room can cooperate with the terrain construction principle. The upper floor is a two-story building. The first floor can be mixed used as a promotion place, service center, material room, agricultural product shop, and product story hall, while the second floor can be used as a homestay space. The homestay can provide opportunities for tourists to interact with local residents in a life experience with an educational and entertaining context and atmosphere in a way that combines local festivals and rural life experiences.

In addition, the construction of the homestay model is a concept of joint participation in the concept of shared economy. It is different from the aggressive operation method of local culture and customs after the introduction of commercial activities. The construction of the houses is funded by the management unit. The management team seeks the repair and reconstruction of the houses with owners in the village that are willing to participate and operate together. Before the construction, the two parties sign a joint operation contract, and the operator will pay for the repair and renovation. Residents provide more than one-bedroom units for management and operation of the management units, and the out-of-town villagers must retain their original living patterns and serve as the owner of the homestay and the management unit of the park. The imagery is based on the experience of the original residents.

This model of sharing keeps the living culture of rural residents and increases their non-industry income without changing the residents’ farming habits. In the case of rural busy, they must also participate in the farming operations of the owner of the homestay, so that the travelers can share the inheritance from the local life style experiencing the meaning of rural life and traditional culture. This model is a concept of complete rural tourism operation for rural residents, funded enterprises, travel tourists, and cultural success. It is one of the effective operational methods for reaching the goal of this project (Table 2). After the completion of the construction of the three phases, the rural operation model of the smart village is stable, and the operational management rights can be returned to the village organization, the government unit or the civil construction unit that originally constructed the smart village. The structure of smart village is based on the benefits of farmers, and is jointly operated by farmers, experts and management units. The company only serves as a consulting and platform operation, and excavates the wealth that originally belonged to farmers and is rich in agriculture, grafted tourism and cross-domain integration. It is a mutually beneficial management platform that complements each other and is the embodiment of the overall economy of agriculture and the emergence of a shared economy.

| Item               | Unit        | Quantity | Reduction | Quantity (after reduction) | Day | Unit price (USD) | Total price (USD) |
|--------------------|-------------|----------|-----------|-----------------------------|-----|-----------------|-------------------|
| Ticket             | person      | 1278     | 50%       | 639                         | 365 | 3.75            | 874,631.25        |
| Story house homestay | room       | 10       | 50%       | 5                           | 365 | 97.5            | 177,937.5         |
| Featured town homestay | room   | 41       | 50%       | 21                          | 365 | 67.5            | 517,387.5         |
| Creative goods     | person      | 639      | 80%       | 511                         | 365 | 3.75            | 699,431.25        |
| Food & drinks      | person      | 639      | 70%       | 447                         | 365 | 9               | 1,468,395         |
| Activity           | person      | 639      | 30%       | 192                         | 365 | 3               | 210,240           |
| Camping            | camp        | 50       | 40%       | 20                          | 365 | 3               | 21,900            |
| Total              |             |          |           |                             |     |                 | 3,969,922.5       |

4. Conclusion
Rural development should make the first favor for local farmers to benefit from farming, instead of only emphasizing the derivative advantages of the surrounding industries, and encouraging
agricultural tourism and integration to forget the importance of the stability of agricultural roots. The shortage of agricultural food and the misappropriation of cultivated land are commercial operations. The plan considers that the appropriate conversion of agricultural land to tourism facilities is feasible, because the tourism industry profits are indeed more profitable and easy to operate than agricultural, but any land conversion must be administered according to rules and regulations, for the basic farmland is the national life field. More attention should be paid to this part of the modification.

Furthermore, proper comment, planning result and suggestion are discussed as follows:

1. This study introduces agricultural big data in the scope of the site plan into the Internet of Things, cloud computing, and central management technologies, mastering the production, logistics, and sales core of agricultural products. In addition, according to the concept of Porter's value chain analysis, all processing or conversion programs will become external profit value, but the value of products extended by agricultural processing or tourism processing is not fully reflected in the basic raw materials. The win-win model has become a dependent industry.

2. To acquire the optimization of land use division, urban planning regulation and Lishan initiative concept which are proposed as references based on the assessment of data with master planning and considers the commons structure, while respecting the traditional community public land use rights and downstream land ecological rights for social responsibility operation planning. For the open community environment and the distribution of internal space of the enterprise, it can play a regulatory role. The future utilization and development of the complex land can also be operated under the most reasonable conditions to avoid the operational dilemma.

3. The integration of upstream and downstream industries through rural development and cross-domain integration has become an inevitable development result. The farmers' profitability is planned for all basics. The initial input cost is only the cost of technology introduction and sales channel laying and overall development. The proportion is lower than the tourism-based planning model, which can completely reduce the starting point of enterprise entry. The cost threshold and the impact of development activities on the environment are reduced, and farmers still maintain their daily routines and traditional habits. Development also allows residents and farmers to bear the brunt of the operation results and profit sharing. It can fully implement the real meaning of low-impact development, from low environmental impact to low cultural impact, enhancing the real income of agricultural production, and at the same time construct rural areas with smart countryside, smart tourism, and smart environment.

Acknowledgements
This work was supported by the Industry-University project of the ecological leisure farm in Waipu Taiwan. The authors acknowledge the financial support from Institute of Stone Park Ecological Leisure Farm.

References
[1] Marvin S and Luque A 2017 Int. J. of Urban and Regional Research 41(1) pp 84-103
[2] Cheng J and Masser I 2004 Environment and Planning B: Planning and Design 31(2) pp 167-194
[3] Lambin E F, Turner B I and Geist H J 2001 Global Environmental Change 11(4) pp 261-269
[4] Fang H, Xu Y, Ye Z, Zhang Z, Pan S, Deng L, Luo Z and Chen S 2014 Int. J. of Sustainable Development & World Ecology 22(2) pp 117-126
[5] Xüling L, Zhaoping Y and Xuegang C 2012 Industrial Survey 2 pp 80-84
[6] Okayama N, Tanaka N, Honda K and Matsumoto R 2017 J. of the Japanese Forest Society 99(5) pp 202-209
[7] Strohbach M, Ziekow H, Gazis V and Akiva N 2015 Modeling and Processing for Next-Generation Big-Data Technologies Springer pp 257-282
[8] Nkomo M, Hancke G P, Abu-Mahfouz A M, Sinha S and Onumanyi A J 2018 Sensors 18(10) p 3215
[9] Mudambi R and Puck J 2016 *Journal of Management Studies* 53(6) pp 1076-1093
[10] Vilajosana I, Llosa J, Martinez B, Domingo-Prieto M, Angles A and Vilajosana X 2013 *Communications Magazine IEEE* 51(6) pp 128-134
[11] Pretty J N and Bharucha Z 2014 *Annals of Botany* pp 1-26
[12] Harshada R, Bhede M and Arati S P 2015 *Int. Journal of Modern Trends in Engineering and Research* 2(7) pp 956-964
[13] Nohl W 2001 *Landscape and Urban Planning* 54 pp 223-237
[14] Walker R 2001 *Ecological Economics* 37(3) pp 357-369
[15] Li X, Ma K, Fu B and Niu S 2004 *Acta Ecologica Sinica* 24(5) pp 1055-1062