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To Uplift the Profitability of Marginal Lands by Cassava Cultivation

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Abstract

Expanding the utilization of marginal land resources in rural areas is regarded as a significant supplement for the sustainable development of modern agriculture for its yield, economic and ecological good. Marginal areas, due to their natural limitations, are only productive for energy crops with strong resistance and tolerance. Cassava, in its longstanding cultivation practices, has marked its adaptability in tropical and subtropical regions. Farmers are allowed to improve reclaimed soils' fertility, while plants' canopy coverage could reduce soil erosion. Besides, cassava tubers to be produced as food or fodder can be counted as soil productivity. Breeding advanced cassava varieties on marginal land under proper intensification management and facilitating policies can indeed increase farmers' income. Some of the projects implemented outside of China speak quite well on that. Additionally, intercropping modes for cassava bring higher incomes than monocropping mode, which simultaneously improves the ecosystem structure and soil conditions. The interspecific cooperation brought by the intercropping pattern has its buffering function and antagonistic effects to counter against plant diseases, pest attacks and weed infestations. It performs as a natural alternative for pesticides and fertilizers with minimal inputs and safe and productive outputs. Although a complete cassava industrial chain has been formed nationwide, there are still challenges like the inadequate use of marginal areas and risks triggered by unfavorable climate, changeable commodity markets, and the composition of the labor force. However, there will still be ample room for further growth of cassava, for recent years have witnessed the acceleration in the circulation of rural land management rights and the stratification of Chinese farmers, which gives an impetus to household management's dominance as well as the improvements

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of rural social welfare systems for the overall agricultural efficiency.

Keywords

Marginal Land, Economic Profits, Ecological Benefits, Planting, Cassava

1. Foreword

Farmland is categorized into productive, marginal and nonproductive levels via factors of its economic values (rents and prices), geographical conditions (temperature, slope and rainfall), ecosystems (protected, entertaining and supporting), and soil suitability (yield capacity and physical and chemical characteristics). Marginal land refers to less productive, profitless and ecologically fragile land that is characterized by its soil barriers, hydrothermal resources constraints and topographic conditions, which is generally designated as saline-alkali soil, yellow cotton soil, purple soil and low mountain and hill red soil. [1] Consumers who are inclined to enjoy agricultural ecology or socio-cultural gains are willing to provide vital information to decision makers on agricultural economic targets. [2] Based on documents and expert opinions, the total marginal areas in Asia have reached approximately 1.70×10^{10} ha, which is available for bioenergy crops to alleviate the allocation pressure of farmlands for fuel and food. [3] In actuality, China possesses approximately 7.800×10^8 ha of marginal land, but a shortfall of 4.67×10^8 ha in arable lands. In the Midwest of the US, for example, Miscanthus is regarded as a biofuel growing in marginal areas, and its overall amount is expected to meet the jet fuel demands by 2040. [4] Accordingly, we could take full advantage of China's marginal areas by growing plants such as sweet sorghum [5] or jatropha [6] to cover the development demands of recyclable biofuels. Quite apart from that, there were cases where farmers increased their output profits by using marginal land as an expanded area for high-quality beef products. Simultaneously, the management worked for wildlife within, and its overall values improved as well. [7] In addition, good management of irrigation and fertilization and judicious use of biopesticides and biofertilizers could produce reasonable yields on poor soils. [8] For instance, the PGPR application will improve the quality and profitability of perennial fragrant grass on marginal land. [9]

Cassava is an important staple food and cash crop worldwide that can be produced efficiently in marginal areas. [10] The experimental site of Nigeria was previously put into cultivation of some arable crops and waterleaf before it being fallow for two years. It is concluded that planting cassava (NR02/0018) genotype would produce higher total tuber yield and economic returns and thus be more beneficial to the farmers. [11] A recent surge in demand has been rising in starch producing, clean energy, healthcare, paper making, and chemical industries. Cassava is taken as an alternative to grains supplied for the forage industry and animal husbandry usage [12]. Meanwhile, its residues, a byproduct from starch factories, whose components are mainly starch and cellulose, can also be used as the feedstock of forage through fermentation, and that achieves cost-effectiveness for its accessibility and giveaway price as well as greater efficiency by recycling.

China is the biggest cassava importer in the world, and its trade deficit is continuously expanding. However, the cassava domestic price has been decreasing since 2011 due to the stagnant performance of the world starch market and low import prices offered by major cassava producers from ASEAN, which propelled a sharp shrink in growing areas for its decreasing profitability, and then cassava industry had encountered a "cold wave". Affected by the high prices of the feedstock of maize and grain increased by the conflicts in Russia and Ukraine, Thailand had decided to accelerate the expansion of its cassava exportation to the Philippines since September 12th, 2022, and urgently required to replace the high-priced raw materials as feedstocks of high-energy animal feed producing. Leading by the optimized development model, marginal areas suited for bioenergy crops in China have reached 6.00×10^8 ha, while for cassava plantations, 1.23×10^8 ha [13]. The volume tells that more intensive cultivation of cassava should become a significant supplement for tillage resources in line with the national agricultural strategy of "Rely on earth and rely on technologies" to alleviate the pressure of insufficient supply as well as stabilize prices when the COVID-19 pandemic enters its platform period. It is also a path for improving the production capacity and ecological benefits of marginal land.

2. Materials and Methods

2.1. Case Survey

On the basis of issues and phenomena came across in "agriculture, rural areas and farmers developments" in China, we've surveyed cassava growing programs and cases in both foreign countries (Zanzibar Island, Myanmar, and the Philippines) and domestic countries (Nanning, Qinzhou, Guigang, and Fangchenggang etc.), cultivating management, yielding and sale market in tropical regions, and cultivations on abandoned and reclaimed lands that have already formed its conventional models.

2.2. Water Loss Assessment

This approach involves slopes and filled and abandoned lands, which are divided into cassava planted and non-cassava planted trial plots for the observation and assessment of water loss. Sampling follows the rainfall with a hole punch for 400 - 500 g of soil from directions of east, west, south, and north within a circle of 20 cm diameters for both planned plots (circling around the stem base) and non-planted plots (random pattern). 30 - 50 g amounts of soils are taken out of well-mixed samples and placed into dry and airtight aluminum containers for weighing (W0), followed by an air drying oven at 100˚C for 24 hours and weighing (Wd), and subsequent calculations for the coefficient of water via formula $(W0 - Wd)/Wd \times 100 = R$. Sample dates are set on the very day of rainfall (D0), and the first (D1), second (D2) and third (D3) sunny day after the rainfall with its soil depth of topsoil (S0), 5 cm (S5), 10 cm (S10) and 20 cm (S20). Three replications are conducted for soil moisture content analysis.

2.3. Evaluations for Growing Cassava on Marginal Land

2.3.1. Wa State, Myanmar

Advanced cassava cultivars GR4, GR891, SC20 and SC9 were introduced for assessment to Pun Hlaing Cooperative Farm in Panghkam of Wa State, Myanmar, on May 17th, 2014. Breeding stems were horizontally planted with a spacing of 1.0 m × 0.8 m, making 16 plants per unit. A randomized block design was adopted with each unit of three replications, and compound fertilizer N-P2O5-K2O was applied in the single basal model for 50.0 g per plant while cassava was kept in irrigated conditions.

On the harvest day of February 1st, 2015, six plants as a group were randomly picked out of each unit and weighed up for their tuber weight and ensued calculations of single plant weight and yield per unit area.

2.3.2. Davao Oriental Province, the Philippines

Advanced cassava cultivars NZ199, GR4, GR5, SC5, SC8 and SC205 were introduced for comparative assessments with local cultivar GY to Barol Lupo Farm in Davao Oriental Province, the Philippines, on April 14th, 2011. Breeding stems were horizontally planted with spacing of 0.8 m × 1.0 m, making 30 plants per unit and each unit 25.0 m^2. A randomized block design was adopted with each unit of three replications, and compound fertilizer was applied in a single basal model for 30.0g per plant while cassava was kept in irrigated conditions.

On the harvest day of March 13th, 2015, six plants as a group were randomly picked out of each unit and weighed up for their tuber weight and ensued calculations of single plant weight and yield per unit area.

Tuber starch content was calculated according to the GST formula: fresh cassava tuber starch content (w) = 210.8 × fresh tuber weight in air/(fresh tuber weight in air − fresh tuber weight in water) − 213.4.

2.4. Intercropping Trials

2.4.1. Maize/Cassava

Cassava was planted under the pattern of 0.7 m − 1.0 m × 1.0 m − 1.5 m with a density of 7500 - 12,000 plants per ha, while maize followed the narrow-wide row pattern with its narrow space of 0.5 m, wide space of 0.70 m - 0.74 m and density of 48,000 - 52,400 plants per ha. Fertilization amounts are organic fertilizer 7500 kg/ha, phosphorus fertilizer 600 - 750 kg/ha, and compound fertilizer 300 kg/ha.

2.4.2. Legume, Chili, Sweet Potato/Cassava

Cassava was planted under the pattern of 0.8 m − 1.0 m × 1.0 m − 1.2 m. Intercropped plants were planted at the same time or a week time of interval. Legume, chili and sweet potato were supposed to be planted in two rows between cassava and coverless from its leaf growth. Fertilization amounts are organic fertilizer 600 - 7500 kg/ha, phosphorus fertilizer 600 - 750 kg/ha, and compound fertilizer 250 kg/ha.

2.4.3. Melon/Cassava

Melons should be planted in the early farming season from February to March every year. When melon seeds were sowed in a hole of 1.5 m - 2.0 m after 15 - 20 days, cassava should be planted aside seedling ridges in two rows with space of 0.8 m × 1.0 m, and applied with organic fertilizer 600 - 7500 kg/ha, phosphorus fertilizer 600 - 750 kg/ha, and compound fertilizer 250 kg/ha. When harvest arrived from May to June, vines, leaves and other debris should be cleaned up, and cassava required a top dressing of 100 kg/ha to increase yield.

2.4.4. Insects Population in Legumes Intercropping

August to September from 2020 to 2022 was a peak occurrence for insects in cassava planting areas. A sticky trap was placed in each unit for three days to count the number of insects for records and analysis.

2.5. Data Analysis

Tools for analysis and graphics: SPSS Statistics 19, SAS 9.0 and Graph Pad Prism 5.

3. Results and Analysis

3.1. Intensive Cassava Cultivation on Rural Marginal Land

Cassava is a widely cultivated staple crop in tropical regions of the world. Its root tubers are rich in starch, which is not only edible but used for the production of starch and animal feed. Besides, they are important feedstocks for the papermaking industry. Cassava is regarded as the first staple food in most African countries, and together with maize, wheat and rice are taken as the major four staple food in Africa. Over 30 countries in Africa rely on cassava as their main food, which currently accounts for more than half of the total production of major food crops. The production of cassava in Africa is capable of meeting its own needs, and it has a small number of exports. But 80% of countries and regions in Africa are still deficient in food. Therefore, cassava is known as the best crop to solve food problems in Africa.

Cassava is widely cultivated in Africa, and grows on mountains and plains for its strong drought resistance. Its growing pattern is similar to that of taro. Buried in the soil, sufficient light and water may lead to a bumper harvest. Africa provides 60% of the world's supplies. Cassava provides long-lasting energy and maintains satiety, which plays an important role for Africans in drought.

In our field trip of tropical and subtropical regions, we found that local growers often plant cassava at the front or back sites of their homes as well as marginal corners at main planting areas (**Figure 1**) to strive to maximize the use of soil resources to produce food and feed crops, and take advantage of natural resources such as sunlight, temperature and water in a natural energy conversion way. Growers told us with excitement that this conventional method of cassava cultivation requires little management for harvest, and what they need to do is to dig out cassava when the growth cycle ends. Additionally, it plays a balancing role in a small-scale agricultural ecosystem.

Figure 1. Growing cassava on rural marginal land ((a) Zanzibar Island, Tanzania; (b) Yangon, Myanmar; (c) Butuan, the Philippines; (d)-(f) Qinzhou, Guigang, Fangcheng City, China).

3.2. Cassava Cultivation for Marginal Land Protection and Prevention of Soil Erosion

In China, "Non-agricultural operations on arable land" are resolutely stemmed, and "Non-food crops cultivation on arable land" is rigorously controlled. Abandoned land restorations must be implemented, and remediation requires endeavor work.

Typical hilly landforms in both tropical and subtropical regions are classified as marginal land, with rough terrain and steep slopes resembling terraced fields. Relatively speaking, cassava is more suitable for growing on marginal land that is reclaimed or restored rather than on land that is replanted or mechanically cultivated. We define marginal land that is reclaimed or restored as abandoned land that can be grown for agriculture or crops, for mechanized new land has more uncertainty. Cassava is a reclaimed land crop (**Figure 2**). On the one hand, it effectively reduces greenhouse gas emissions, which brings benefits to the environment. On the other hand, it is helpful for land restoration, which is profitable for environmental protection. Besides, it provides potential contributions to energy security [14]. Cassava helps the sustainable utilization of land resources and enlarges the arable land areas, which effectively alleviates the contradiction between population and land resources and that in further promotes social and economic developments.

Figure 2. Cassava growing on reclaimed and restored marginal land ((a) newly reclaimed land; (b) abandoned land under restoration; (c) reclaimed slop).

Through the ensued observation after rainfall of reclaimed and restored land where cassava grows, we found that cassava blocks and slows down the impact of rainwater acting on loose soils, as its root system works as a net (**Figure 3(a)-(d)**) to maintain soil, and that effectively reduces soil erosion. In addition, the root system of cassava can also enhance the soil and water conservation capacity of the slope. The corresponding growth indicators (tiller number, coverage, plant height) show a highly significant negative correlation with the amount of runoff and sediment on the slope.

The analysis of soil moisture content shows that compared with unplanted areas, the moisture content of planted areas has significantly increased by 22.4% (**Figure 3(e)**) since soils in unplanted areas are more easily infiltrated by rainwater, which results in runoff forces scouring out into deep soils, what's more, soil moisture content sharply decreases over time. In contrast, rainwater decreased slowly in planted areas (**Table 1**), with its soil layers in varied depths exhibiting good water retention, which supplies sufficient water for cassava needs. It is proved that cassava cultivation reduces soil water loss and is beneficial for the restoration and reclamation of marginal land.

Figure 3. Trials for water loss observation on cassava planted marginal land ((a) landfill reclamation; (b) (c) slope reclamation; (d) abandoned land restoration) and difference analysis of soil moisture content ratio (e).

Table 1. Comparative analysis on post-rain soil moisture content of different time and sites.

Test level		Moisture content ratio % (Duncan's analysis, p = 0.01)	
		Control	Planting cassava
Sd-0	D0	126.08 ± 11.55	126.92 ± 7.68
	D1	42.24 ± 5.65	62.29 ± 4.52**
	D2	14.16 ± 2.64	33.22 ± 2.68**
	D3	8.42 ± 3.57	19.59 ± 4.52**
Sd-5	D0	130.4 ± 6.23	134.86 ± 10.66
	D1	60.95 ± 3.42	71.13 ± 2.10**
	D2	45.53 ± 2.55	65.30 ± 3.26**
	D3	29.95 ± 6.71	42.88 ± 5.49**
Sd-10	D0	92.22 ± 1.96	91.94 ± 2.19
	D1	71.72 ± 2.26	79.47 ± 3.19**
	D2	55.5 ± 2.55	73.89 ± 2.45**
	D3	40.26 ± 5.45	71.90 ± 8.60**
Sd-20	D0	91.21 ± 2.03**	82.67 ± 3.34
	D1	66.66 ± 5.14	81.44 ± 1.93**
	D2	48.25 ± 2.77	81.81 ± 3.76**
	D3	40.08 ± 7.46	60.67 ± 6.19**

3.3. Case Study of Cassava Cultivation on Marginal Land

In order to implement the nation's "going out" strategy and expand the influence of China's agricultural technology, Guangxi Subtropical Crops Research Institute started to introduce advanced cassava varieties overseas (**Figure 4**) from 2010 to 2015. Contents are as follows: 1) Four varieties were introduced to Wa State, Myanmar that seasonal yield reached 25500.00 - 54900.00 kg/ha and fresh tuber starch content was up to 27.55% - 30.05%; 2) Six varieties were introduced to Davao Oriental Province, the Philippines that seasonal yield reached 26398.00 - 34304.00 kg/ha, which increased 29.61% - 68.42% than local variety GY. Five out of four cultivars' tuber starch content was up to 26.70% - 29.20%, higher than that of GY (26.80%) 1.20% - 2.40%, and left SC8 0.1% lower behind.

On account of the deficiencies in infrastructure, financial support as well as policy guidance in both Wa State, Myanmar and Davao Oriental Province, the Philippines, growers normally have cassava grown in a natural way on the unused sites around their homes or intercropped in coconut orchards with a single variety and extensive management without fertilizing and weeding. When the harvest is approaching, some growers would first inquire about the purchasing price and only when the prices are acceptable will they dig cassava out and sell. The truth is most growers are relatively poor who sell cassava for money and bad weather at a low price to the nearby factories for beer, animal feed and food production before cassava goes rotten. The breeding program has selected suitable, high-yield and high-starch varieties for local cultivation. Local cassava industrial association calls for closer collaboration between government and private sectors for providing loans, seedlings, and technical support to growers, connecting production and sales, being the driving force of farmers for cassava cultivation on marginal land, increasing their earnings for bigger incentive effects and developing opportunities in addition to expanding raw material sources for cassava processing factories.

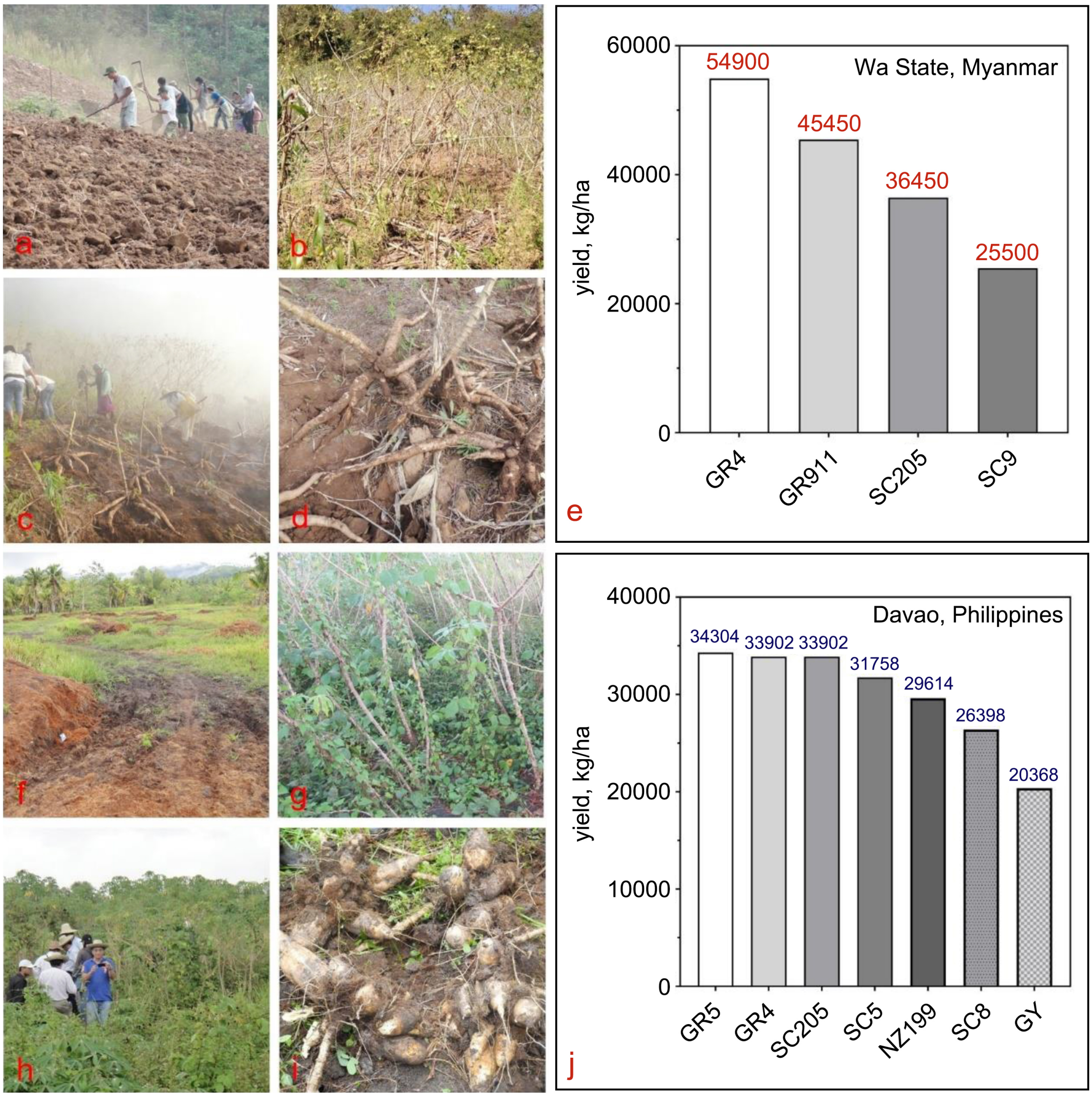

Figure 4. The introduction trials and yielding analysis of Chinese cassava cultivars on marginal land of Wa State, Myanmar (a)-(e) and Davao Oriental, the Philippines (f)-(j).

3.4. Economic and Ecological Benefits from Cassava Intercropping

Intercropping crops mainly include peanut, maize, sweet potato, pumpkin, watermelon, wax gourd, muskmelon, chili, and soybean (**Figure 5**). Compared with monocropping, intercropping raises profits by 1.48% -135.42%, which has a striking beneficial effect (**Table 2**). Guangxi province is the biggest cassava producer in China, and its intercropping pattern is a conventional cultivation widely used in cassava production. Intercropping allows varied crops to complement each other in terms of spaces, time, soil resources, and adaptability, which efficiently utilizes light, temperature, water and heat to reduce the pressure out of spaces competing during crop growing and improves land use efficiency as well as yield. On account of inputs and price fluctuations, growers tend to choose intercropping and double-cropping adaptive crops to increase profits. Intercropping mode of cassava with melons had the highest profit, but they also had the greatest risks from cultivation and market.

Recorded data showed the insect population had sharply reduced by 118.59% compared with the insect amount in legumes (**Figure 6**), which indicates that legumes intercropping modifies the ecological structure as well as environmental conditions. Pests' preference for legume leaves is a natural trigger for two plants' synergistic interaction to alleviate diseases and exalt efficiency. Pest concentration is conducive to assembling their natural predators for breeding with the proceeding purpose of biological prevention to effectively control the pests, which does little harm to yields and will reduce pesticide inputs. The overall advantages speak clearly that cassava and legumes intercropping pattern decreases production inputs, improves multiple cropping index and increases per unit yields for green development crops.

Figure 5. Cassava intercropping trials on marginal land ((a) peanut, (b) maize, (c) sweet potato, (d) pumpkin, (e) watermelon, (f) wax gourd, (g) herbage, (h) Chinese herbal medicine).

Table 2. Profits analysis on cassava marginal land intercropping.

Cultivation mode	Yield, kg/ha		Price, kg/CNY		Income, CNY		Total	Inputs, CNY	Profits, CNY
	cassava	intercrop	cassava	intercrop	cassava	intercrop			
cassava	42,450	0	0.52	0.00	22,074	0	22,074	3525	18,549
cassava & peanut	35,550	1800	0.52	7.00	18,486	12,600	31,086	4290	26,796
cassava & maize	33,000	6750	0.52	1.80	17,160	12,150	29,310	5325	23,985
cassava & sweet potato	32,250	7500	0.52	1.70	16,770	12,750	29,520	6300	23,220
cassava & pumpkin	31,050	30,000	0.52	0.67	16,146	20,100	36,246	5355	30,891
cassava & watermelon	35,250	33,450	0.52	1.00	18,330	33,450	51,780	14,250	37,530
cassava & wax gourd	33,000	37,500	0.52	0.60	17,160	22,500	39,660	5550	34,110
cassava & muskmelon	34,650	32,250	0.52	1.20	18,018	38,700	56,718	13,050	43,668
cassava & chili	33,600	26,700	0.52	0.80	17,472	21,360	38,832	8250	30,582
cassava & soybean	37,050	1200	0.52	3.13	19,266	3756	23,022	4200	18,822

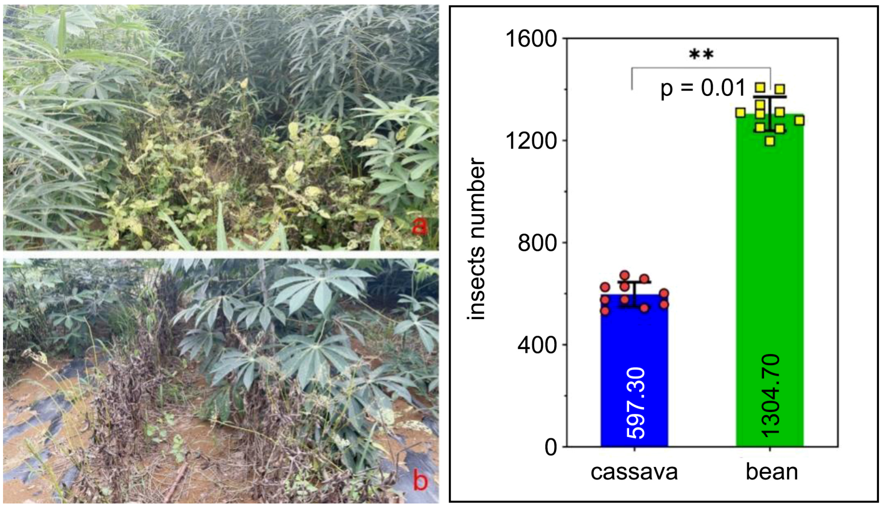

Figure 6. Analysis of pest control under cassava and legumes ((a) soybeans, (b) black beans) intercropping model on marginal land.

3.5. The Suitability of Cassava Cultivation on Marginal Land for Present Agriculture Development

Under the advancement of urbanization in China, over 80% of young people leave the land to find work in towns and cities every year, and the elderly and children are left behind in rural areas where there is a shortage of young adult labor. Incomes and values from varied types of arable lands are constantly decreasing especially in mountainous areas where marginalization of arable land is severe, there are often cases of abandoned farmland or cultivated land for eucalyptus trees growing. Guangxi has followed "advanced cultivars plus effective methods" guidance, adopting intensive measures and managing water and fertilizers to fully ensure yield stability and cassava quality. Implemented projects from 2020 to 2021 showed that the elderly in rural areas in Guangxi, as the main labor force, had achieved good profits (**Figure 7**) on marginal land cultivation of cassava, which was mainly reflected on 1) the spot buying price for fresh tubers may reach to 16,500 to 22,500 yuan per hectare, which equals to 550.00 to 750.00 yuan per ton. Normally middlemen charge 70.00 - 90.00 yuan per ton as a delivery fee and take cassava to the starch processing plants for sale; 2) Influenced by reclamation policies, cassava seed stems are partially in short supply over recent years. Organized cassava seed stems are purchased at a price of 1000.00-1200.00 yuan per ton and resold and distributed to places for planting, and peasant farmers could gain a considerable income in the spring of the following year and put it into reproduction.

Figure 7. Marginal land cultivation of cassava ((a) (b) harvest, (c) seed stem buying, selling and distributing, (d) fresh tubers purchasing).

4. Conclusions and Discussions

Vegetation coverage is a commonly used water conservation measure in arid and semi-arid areas [15]. Increasing vegetation coverage or reducing surface exposure can effectively reduce soil and water loss in runoff plots [16]. The coefficient of soil and water conservation effect is negatively correlated with precipitation evaporation and positively correlated with plant primary productivity calculated from vegetation coverage [17]. The limiting factor for plant growth in a watershed is soil moisture content, which increases soil water retention capacity and improves tree survival rate. Planting cassava on marginal land significantly improves soil moisture retention, allowing plants to resist rainwater and divert water, reducing the impact of rainwater and erosion on top soils [18].

Results analysis shows that cassava intercropping soybeans produces the lowest profit growth, yet the resistance and adaptability of soybeans decrease the occurrence of plant diseases and pest damage [19]-[22], which efficiently cuts down loss and helps cassava to grow. In fact, increasing yields and potential benefits might be triggered by the mycorrhizal networks when intercropping [23]. Intercropping pattern leverages the dual advantages of crop marginal effects and floral nitrogen fixation. Certain rhizobia strains have formed effective symbiosis with their host legumes under the interaction of salt, heat and acid, which effectively improves soil organic carbon content and water retention capacity [24], diminishes the extra usage of fertilizers and pesticides [25] that brought by compacted soil and decreased fertility and alleviates land resource conflicts between food and oil crops to reach a balance and a high yield.

The agricultural workforce in tropical and subtropical regions of China consists of household peasant farmers facing the aging trend, which will suppress the decision-making related to the agricultural land transfer process. Cassava, featuring its strong adaptability, resistance to drought and barren soil, and few diseases and pests, has become the very right crop planted on large slopes and steep terrain with little management. The truth is a complete cassava industrial chain has been formed, with the existing small to medium-sized starch processing plants built.

One of the vital issues that needs to be fully considered is the diminishment of land abandonment and devaluation during the implementation of the rural revitalization strategy [26]. Cassava has its natural disadvantages of relatively low benefits and is susceptible to the market and natural risks. Those vulnerabilities divert growers' attention to other fruitful crops, especially when the labor transfer policy has a side effect on farmland productivity [27].

The development of the Chinese "Three Rural Issues" concerning agriculture, rural areas, and farmers has stepped into a dilemma of repetition and is calling for innovation due to obstacles such as insufficient labor force, agricultural marginalization, and an aging population. Chinese rural areas are facing challenges brought by the acceleration of farmland management right transferring and stratification of farmers, which requires a stable social order and a household-oriented managing dominance assisted with other innovative managing entities in agricultural production, additionally, improvement of mechanization and socialization-related services [28]. For instance, a lightweight harvester for cassava picking in hilly areas will improve efficiency and productivity [29]. Uplifting the added value of agricultural products in mountainous areas could reach a dynamic balance between marginalized arable land and rural labor loss. Making endeavors on differentiated land management and farmland-integrated renovation would fully utilize the land resources [30]. Assisting the elderly workforce to shift farmland management rights to entities that are more productive helps the government to improve and upgrade the social welfare system for rural areas [31].

When harvest come growers usually dig up fresh tubers and leave cassava stems randomly in the field over winter time. Typically, more than 50% of stems go rotten in the span of three to four months' time, with the leftover quantities far from enough for the approaching planting season of spring. Regarding this phenomenon, we have written a handbook called "Technic Manual of Cassava Seed Stems Cultivation" for growers' guidance under the purpose of reducing growers' loss and helping to set up a sustainable mode for cassava growing.

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Conflicts of Interest

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